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THE
LARYNGOSCOPE.

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OTOLARYNGOLOGY IN TRANSITION.*
(PRESIDENTIAL ADDRESS.)

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Adequately to express appreciation of election to the presidency of this Society is indeed difficult. Alas, that my musical skill does not permit emulation of our distinguished conductor of the Boston Symphony Orchestra who under somewhat similar circumstances responded with a solo on the base viol! I can only say that my appreciation of this honor is deeper than I can voice in words. For the first time, but most assuredly not the last, the presidential mantle has fallen upon the filial shoulders of the next generation. This Society was very dear to my father and from my earliest recollection, its name has been a household byword. When I survey the long list of my distinguished predecessors, I am profoundly sensible of my responsibilities. They have been greatly lightened by such staunch secretarial support as must be experienced to be believed.

Once upon a time there was a man who dwelt on an island and the island was the island of otolaryngology. Throughout the island there was none to dispute his authority, the soil was fertile, the climate propitious and the harvest abundant. Daily the man toiled in manifold activities and the reward of the labor was his alone. In his orchards the blossom-covered boughs were heavy with fruit, and the fruit of the tree was the tonsil.

*President's Address presented at the Fifty-second Annual Meeting of the American Laryngological, Rhinological and Otological Society, Inc., Atlantic City, N. J., April 7, 1948.

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His herds and flocks multiplied and increased, affording rich returns, and the flocks and herds were the otitic infections with all their complications. In the hills were mines containing rich ore, where the man dug and delved on their surface, and the mines were the mines of deafness. High on a ridge the man set up a telescope and studied the sun and moon and stars, and the sun and moon were foreign bodies and the stars were the stars of pulmonary suppuration.

With these and other productive activities the years passed and the man prospered. And lo, one day, as he wandered toward his orchard he descried other men busily plucking from the branches the fruit, which was the tonsil. And the man ran toward them crying out, "These are my orchards and their fruit is mine; depart whence ye came." But they heeded him not. And he said unto them, "Who are you?" and they answered and said, "We are general practitioners, surgeons and pediatricians from the mainland and seeing these orchards we, too, wish to share in the harvest." And the man would fain have argued with them but that they outnumbered him so many fold.

And as he turned away there came running to him one who said, "Alas, a great sickness has befallen your herds and cattle, sheep and goats, all those that are yclept the otitic infections. Some lie dead, others sicken and are enfeebled." And the name of the sickness was chemotherapy. And the man could scarce bring himself to gaze upon the sight.

And one evening as the man climbed the hill to his telescope, behold, two strangers stood guard over it and sought to bar his way. And the man said unto them, "Who are you and by what right do you usurp my telescope?" And they answered and said unto him, "We are thoracic surgeons. Henceforth we will observe the stars of pulmonary suppuration. You may if you choose still gaze at the sun and moon that are foreign bodies, the rest of the heavens are ours."

And yet again as the man labored with pick and shovel at the mines of deafness there approached him men with drills and shafts and motors with which they straightway set to

work to bore deeply into the earth. And the man, bewildered, accosted them and said, "Who are you?" And they answering him said, "We are fenestrators from a still smaller island. With new methods we have learned to tap the hidden wealth of this mine far beyond your knowledge or capacity. Would you join us, you must learn our art and techniques, apprenticing yourself to master fenestrators. Otherwise, there remain for you only the few external nuggets at the surface and the scattered hillocks, which are cerumen."

And the man, seeing one after another of his possessions stripped from him, bowed his head and wept aloud.

Further to elaborate this little allegory would but risk mixed metaphors and distorted figures of speech. Surely my object is plain — to suggest that since its early beginning many changes are taking place in the conventional field of otolaryngology which are becoming of increasingly vital concern to every practitioner of this specialty. The once virgin island which I have crudely described is no longer the uncontested property of the otolaryngologists but is daily suffering encroachment, modification and, as it were, erosion from numerous directions. I have named only a few of the more outstanding ways in which this is taking place. It is common knowledge that more tonsillectomies are performed every day — however skillfully or otherwise, by general surgeons, physicians and pediatricians than by laryngologists. That chemotherapy has made enormous inroads into the fields of surgical otology — no one can deny today. That increasing numbers of diagnostic and therapeutic bronchoscopies are being performed by thoracic surgeons is no longer a matter of debate. I might easily have added to the trials of the solitary dweller on his hypothetical island the competition of the allergist, the roentgenologist, the plastic surgeon, the faciomaxillary specialist, nay, even (with the upsurge of psychosomatic medicine) the psychiatrist. My reason for inclusion of fenestration as an encroachment will appear in due course.

That many of these changes have proved of immeasurable benefit and advantage to the patient is self-evident and needs no comment. I am concerned here only with their effect on

the practicing otolaryngologist and particularly those men who make up the great body of the specialty in small cities and towns far from the relatively few large medical centers. It is from these men that one hears on all sides the complaint that the good old days of otolaryngology are gone, that a sort of Gotterdammerung has set in and that the future looks dim. In the face of these gloomy forecasts it is not surprising that a few loyal and more far-sighted leaders of our profession have protested and declared that on the contrary the prospects for otolaryngology were never brighter. This morning for a few minutes I would like to examine this paradoxical situation with the hope of perhaps some clarification of it.

As in most controversial issues of this sort there is something to be said on both sides. We must, I think, at the outset recognize two major subdivisions in what is commonly designated as the specialty of otolaryngology — one the science and the other the practice. Granted that ideally they should be combined as an integrated unit, practically they are widely separated. Considering the purely scientific face of the shield, we must all agree that the future of otolaryngological research, investigation, experimentation and hence of new discoveries is limitless. Aided by such modern advances as high speed photography and the newer knowledge in allied branches of science, otolaryngological research is on the march. It must, however, be acknowledged that most or all of such work can be done only in teaching institutions and hospital laboratories with adequate specialized equipment, and by men with exceptional skill, interest and aptitude and supported by endowments, grants or other financial backing available to only a limited extent. Given all these, the future of scientific otolaryngology need not concern us further. But how stands the matter for the man who enters the practice of otolaryngology as a principal if not sole means of livelihood, relying only upon his own skill and training and with the expectation that adequate opportunities will be available for the exercise of these? I believe that the constrictions and encroachments which I have suggested are to such a man matters of grave import at the present time.

If on opening his office he finds general practitioners freely performing tonsillectomies, pediatricians treating otitis media and chest surgeons performing their own bronchoscopies, may he not wonder how he is to make economic headway against this tide of unexpected and perhaps in his opinion unwarranted competition? To the well established and securely reputed specialists who make up this Society the problem may seem unimportant. For those fledglings who have yet to leave the nest and, incidentally, their families to support, I conceive it to be colossal.

Lest it be argued that this point of view is a personal and hence a biased, perchance even a distorted one, I should like briefly to summarize the results of a questionnaire sent to 500 members of the American Academy of Ophthalmology and Otolaryngology, excluding all members of senior societies. These men, the majority living in smaller cities and towns of uniform geographical distribution, were selected as being located where the problems under discussion would be most likely to be operative. If percentage of reply to a questionnaire is any indication, the interest in this matter is widespread and lively. Many replies contained comments far beyond the simple questions posed.

These men were asked basically if they thought that the field conventionally comprised by otolaryngology was shrinking, and to this question 86 per cent replied in the affirmative. The basic question was broken down by asking an opinion as to whether this shrinkage was the result, *1.* of the introduction of chemotherapy and its application to our special field; and *2.* the encroachment on the conventional field of otolaryngology by the general surgeon and practitioner, by the thoracic surgeon, by the allergist, by the roentgenologist and by the plastic surgeon.

As might be expected, 95 per cent of the replies associated the shrinkage with chemotherapy. The cause, either singly or in combination, was laid at the door of the general practitioner in 66 per cent of the replies, of the thoracic surgeon in 50 per cent, of the allergist in 66 per cent, of the radiologist in 33 per cent, and of the plastic surgeon in 66 per cent.

These figures would scarcely pass muster in a chemical analysis, but they are sufficiently accurate to give authenticity to the opinion that the rank and file of practicing otolaryngologists are convinced that a problem exists which merits the serious consideration of all those who are interested in the future of our specialty and in the training of those who must meet these changing trends.

Let us briefly examine the principal items summarized in the questionnaire.

The opinions with respect to the effect of chemotherapy on the practice of otolaryngology need, I am sure, little elaboration. That it has admittedly curtailed and in some instances well-nigh eliminated formerly commonplace surgical procedures is of insignificant consequence in comparison with the benefits to humanity. The greatest risk lies in too great a reliance on chemotherapy to the neglect of competent surgery when indicated, the very infrequence of which poses a problem in the surgical training of internes and residents.

That we must continue to expect competition from general surgeons, practitioners and pediatricians in procedures which we feel are rightfully ours by virtue of superior skill and knowledge is, I think, a foregone conclusion. It is a problem beyond the scope of these remarks and one for which I visualize no immediate solution.

Bronchoscopy: Despite the relatively unimpressive percentage (66) of replies expressing concern over the nationwide increase of performance of diagnostic bronchoscopy by or under the direction of thoracic surgeons, this situation is an established fact. Its greatest threat to the laryngologist lies in the deprivation of endoscopic experience so necessary if he is to continue to deal with the occasional foreign body which the thoracic surgeons still seem disposed to relegate to him. That this loss is no figment of my imagination can be easily proved and has been discussed in the Mosher birthday volume of the *Annals of Otolaryngology, Rhinology and Laryngology.* To meet in some measure this dilemma, it has been proposed that those laryngologists interested in this field follow the

example of a small number of our members who as pure endoscopists undertake to cover all diseases pertaining to the air and food passages, from the larynx to the duodenum. These men leave to their confreres all matters relating to the tonsils, sinuses and mastoids, if any, hoping for and, in certain cities, receiving such reciprocal cooperation that their economic needs are adequately met while restricting themselves to the field of endoscopy. Chest surgery, however, does not fall within their province, and only in the largest cities and medical centers could a man restrict himself to this radical limitation of activity.

Less fear was expressed (33 per cent) of the activities of the roentgenologist than of any of the other competitors; nevertheless, the vastly improved and extended uses of Roentgen ray therapy and radium in the treatment of malignancy and other lesions of the ear, nose and throat cannot but have their effect by reducing the amount of surgery which formerly provided the only resource in dealing with such lesions. The present wave of enthusiasm for radiation therapy of the nasopharynx clearly exemplifies the importance of a closer liaison between the radiologist and the otolaryngologist, if the latter is to carry out such therapy with any true appreciation of its possibilities, merits and dangers.

Among the many comments repeatedly supplementing the answers to the questionnaire there occurred again and again the opinion that the otolaryngologist must greatly amplify his basic knowledge of allergy. The relatively recent formation of the American Society of Ophthalmologic and Laryngologic Allergy is ample evidence that a strong movement is under way to expand and fortify the allergic knowledge and interests of the otolaryngologist. Its leadership is the best and its future is bright.

The almost as frequent suggestion that rhinoplasty be added to the field of otolaryngology is not surprising in view of the nationwide upsurge of this offshoot of conventional rhinology. As a surgical field, it would still seem to be a territory of dispute between the rhinologist, who considers the nose to be

his by right of eminent domain, and the plastic surgeon, who considers it as merely one more anatomical opportunity for his specialized procedures.

Again there is something to be said for both points of view, but considering the frequency of deviations from an ideal nasal configuration and the human urge to correct this, the present enthusiasm for rhinoplasty is exposed to certain risks and temptations too obvious to mention.

If, then, it be acknowledged that a serious problem exists for the otolaryngologist of the future, and that changing conditions must be met by changes in methods of training, how shall this be done? Various measures have been suggested; the majority more idealistic than practical. It has been proposed, for instance, that the future otolaryngologist should expand his present field anatomically to include the entire head, perhaps even the neck and thyroid gland.

Consider for a moment the present recognized special fields with which this would bring him in conflict. Already brain surgery is one of the most rapidly expanding and technically exacting of specialties demanding the full attention of an increasing number of highly trained workers. Plastic surgeons are as much at home in the nasal and aural reconstruction as in plastic work elsewhere in the body. Faciomaxillary surgery is constantly gaining ground as a separate surgical specialty, and surely any work in the neck is part and parcel of a general surgeon's routine.

Such a novel and revised anatomical specialization would necessitate a completely new concept of the place of the otolaryngologist in the field of medicine by all referring groups, particularly the family physician, and I doubt if at the moment it can offer a feasible solution to the problem. Training in such a composite group of surgical techniques would entail so prolonged a preparation as to be far beyond the time available to most men.

A brief word as to fenestration. One frequently encounters the optimistic opinion that the loss of aural surgery incident to chemotherapy need cause no concern since it has been sup-

planted by fenestration. When I survey the work of certain otologists, endowed with the highest degree of surgical skill and enthusiasm, able to carry on experimental investigation under ideal conditions and aided by foundations and special grants, who are still dissatisfied with their results and who are still seeking the answers to ever recurring problems, I cannot believe that this operation has as yet reached the point where it can naively be added to the stock in trade of the average practicing otologist. I am doubtful if, either by observation of the work of other operators, or by self-tutelage, he can safely undertake such work except after training under conditions available to only a small minority.

Like marriage, fenestration should not be entered into lightly or unadvisedly, but soberly and with the full realization that brilliant as have been the results, most of these have been largely in the hands of a few talented operators whose endless hours of patient effort have brought this operation to its present state of development. Until such time as this procedure becomes practical in the hands of the average otologist, patients suitable for operation should, I think, be referred to those men best qualified to perform it, and to this extent it constitutes another limitation in the field of conventional otolaryngology. It is precisely this point of view that is now taken by the Veterans' Administration.

The declining incidence of otitic and, to a lesser extent, rhinological complications poses yet another problem to the prospective practitioner of otolaryngology. With the diminution of former commonplace surgical procedures goes hand in hand a lessened competence in dealing with them when they do arise. Time was when an interne could look back on a service experience of 100 personally performed mastoidectomies. Today he has been well regarded by his seniors if he can boast of 20. Who of us today can claim the personal and soul-trying experience with brain abscess or sinus thrombosis of the men of 15 years ago? Where is adequate training for these occasional but always serious emergencies to come from? The modern otologist has come so to rely on chemotherapy that without the classical signs of hidden danger he stands on

slippery ground; moreover, reliance on chemotherapy to care for possible residual infection tends toward incomplete and timid surgery, with possibly disastrous results.

In the above mentioned questionnaire an opinion was solicited as to whether the otolaryngologist of the future would be wise to add ophthalmology to his other field of endeavor. At the present time there are in the United States almost three times as many men who combine the two specialties as practice otolaryngology alone, these latter being found quite naturally in the large cities and medical teaching centers. Many physicians have told me personally that with such a combined practice the bulk of their income derives from ophthalmology. In this connection the problem of a double period of postgraduate training enters the picture for the man whose resources make it imperative that he enter active practice as soon as possible. Indeed, when one considers what might properly be said to constitute entirely adequate preparation for the otolaryngologist of the future, I am constrained to think that nothing short of government subsidy would suffice to see many men through the long years of gestation. Even when hatched, it may be found that he has been born a trifle prematurely.

Having tried briefly to present what I think constitutes a vital problem to the present-day practicing otolaryngologist, I feel chagrined that I can offer no assured solution. In the face of such inroads on our field, I can see nothing save a vigorous effort so to expand the training of the future otolaryngologist that he is better enabled to go forth in battle to regain at least some of the lost territory. To this end, it seems to me that we must amplify the training period or interneship to include an allotment of time, quite apart from the customary specialized program, to the allergic service, the thoracic service, the plastic service and the roentgenological service of a large hospital; in other words, something approaching a rotating interneship in those medical fields in which the encroachments noted above are being most keenly felt. With improved fundamental training in these fields the future otolaryngologist will be able to apply the knowledge gained to his

own special domains and thus be in a better position to defend himself more vigorously and effectively.

It will be argued that this plan will still further increase the time before entrance into active practice. To meet this objection it may be possible to steal time, a month here, a month there, from conventional otolaryngological activities. Better training in fundamental allergy might well come at the expense of fewer submucous resections, time spent on the radiological service might be bought at the price of fewer tonsillectomies. Always the training period seems to be expanding. Perhaps we should curtail it further back—in college, in medical school — in the general interneship. Each segment of the curriculum is loath to see its own portion yield ground to any other.

I bring these matters to the attention of this Society because its members are by and large the foundation pillars of postgraduate education and training of future otolaryngologists. I believe the subject demands the serious and thoughtful consideration of all those who are concerned with the future of otolaryngology.

We are rapidly reaching the point where it is felt that the well rounded and adequately prepared otolaryngologist must be a composite paragon, trained as an anatomist, a physiologist, a biochemist, an audiophysicist, an allergist, internist, radiologist, surgeon and even psychiatrist. The founders of this Society would have felt this to be a fantastic task. Were we able to produce such a superman, I fear that, on emerging from his training chrysalis, he might appear little more than a gray-haired and stoop-shouldered figure, leaning heavily on his cane.

MINIMAL SHOCK PULSE TRAUMA TO THE COCHLEA — ACUTE AND CHRONIC.*†‡

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Historical Background: The fact that the ear can be damaged by loud sounds has been known for as long as otology has become a specialized field of clinical medicine — about a century. Toynbee described changes in the cochlea in a man who had been exposed to a thunderbolt. With the development of suitable histologic techniques, the resultant pathology in the labyrinth received closer attention. Sporadic accounts of histologic changes in the cochlea of patients exposed to excessive noises appear before 1900 — such as the paper by Habermann,[1] in 1890. Following the turn of the century, a great deal of attention began to be directed to this problem, particularly with the work of Wittmaack.[2] The experimental approach was well founded by him, but his interpretation of the site of primary injury and the avenue of propagation of the trauma was soon disputed by others. He believed that the stimulus was bone conducted and resulted in primary injury to the ganglion cells, and that changes in the end-organ and nerve fibres were secondary to this. Experimental procedures were carried out by von Eicken[3] and others to demonstrate the importance of the air conduction pathway for the traumatizing stimulus. A clear-cut difference of opinion developed between the schools of Wittmaack[4] and Siebenman[5] on these questions and this was extensively discussed in the literature.

Before the first world war considerable information was obtained on the effect of blast on the ear, but of chief interest to most investigators at this time was the effect of pure tone trauma in producing limited lesions in the end-organ. The

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experiments were carried out to help clarify the function of the cochlea. The effect of blast injury was reported by Wittmaack,[2] Yoshii,[6] Hoessli,[7] Hoshino,[8] Prenant and Cortex[9] and von Eichen.[3] The rôle of postmortem degeneration of the end-organ was recognized early and care was taken in the fixation of experimental material as well as in the interpretation of human specimens removed some time after death. Hoessli used a Swiss ordnance revolver, firing five blanks at 30 cm. The stimulus was not great enough to appreciably damage the conduction apparatus. He showed that in animals the end-organ was spared if the canal was occluded by cotton and if the incus had been removed. A rather limited damage of the end-organ was noted, beginning at the lower middle coil. Yoshii used a pistol shot strong enough to break the eardrum in all his animals. The round window was torn in one animal. Widespread extensive damage to the end-organ along with hyperemia of stria vascularis and blood in scala tympani was found, as well as some evidence of recovery.

The problem of blast trauma and the value of protective devices was reviewed by Guild[10] during the first world war and experimental work was carried out clearly demonstrating the various degrees of acute end-organ disintegration as the result of blast, with the early changes in the outer hair cells. He used a 45 Colt automatic with Peter's ammunition at 15 cm. and regularly ruptured the drum in the unprotected ears. The clinical experiences of that war were extensive and the otologic problem from that time on has been well recognized. In the years between the two world wars, experimental observations in this field were extended. A considerable amount of the experimental work was published in the Japanese literature, some of which has been inaccessible to me. In one volume of the *Kyoto University Medical Journal* there are several papers on acoustic trauma with excellent photomicrographs of the damaged guinea pig cochlea. Yoshida[11] investigated the effect of the slow, large sinusoidal pulses of a pneumomassage machine upon the ear of the guinea pig. He produced both middle and inner ear damage with this procedure after 10 to 20 days' exposure. The upper third and fourth

coils showed the greatest damage, with secondary degeneration of the nerves and spiral ganglion. Takezawa[12] was interested in the question of whether air or bone conducted sound was more important in damaging the ear. Takezawa produced peripheral nerve degeneration and end-organ changes principally in the second coil by exposing guinea pigs to factory noise and to a 2,350 cycle siren at 100 db. He studied bone conduction trauma by placing animals on a platform vibrated at 1,800 cycles per second. After two months' exposure he found ganglion cell and nerve degeneration in the upper coil with relative sparing of the end-organ, except for outer hair cell changes and degeneration of the stria vascularis. Changes in the bony capsule were also noted. He, therefore, differentiated the lesions produced by air conducted and a bone conducted acoustic stimulus. He pointed out that Wittmaack produced damage in a similar position of the cochlea with a 30 cycle stimulus; however, the exact nature of the stimulus could not be ascertained with the methods then available to these investigators.

In recent years, experimental work has been carried out with more carefully controlled stimuli. Thus, Lurie, *et al.*,[13] used exceedingly powerful measured pure tones for very short intervals and pointed to the disruption of the mesothelial cells below the basilar membrane as the first sign of end-organ damage, even before the changes in the outer hair cells have taken place. Ruedi and Furrer[14] investigated several aspects of this ploblem. The question of bone conducted pulses was considered in head trauma without fracture. They pointed out that Uffenorde had called attention to the similarity between the deafness from such trauma in man and that due to noise. Under local anesthesia they exposed the mastoid cortex in several volunteers and struck it a sharp blow with a metal hammer. This resulted in a temporary high tone loss in the audiogram. The subjective sensation was described as resembling that of a pistol shot. In addition to a pathologic study of a patient exposed to a mine explosion, they carried out experiments with guinea pigs, exposing animals to the detonation of a 2 cm. gun and to various amounts of explosive, such

as tetryl. They differentiated between these two traumatizing stimuli on the basis of the duration of the resultant shock pulse, the former lasting 0.9 of a millisecond, the latter 2.85 milliseconds. They tested auditory function by means of the pinna reflex. They also studied the result of exposure to synthetic noise. Complete obliteration of the pinna reflex or a high tone dip, maximum at about 5,000 cycles, was obtained on long exposure to the synthetic noise, and outer hair cell damage was all that could be demonstrated. Exposure to gunshot was done without visible damage to the drum. Half of these animals showed a loss of the pinna reflex. End-organ changes in the lower middle coil were observed and 80 days after exposure degenerative changes were clear-cut. In contrast to the noise and gunfire trauma, the animals exposed to the detonation of explosives like pentryl showed evulsion of the drum and other middle ear damage. There was loss of the pinna reflex attributed to this middle ear damage. The end-organ appeared to have been initially undamaged, but there were tears in Reissner's membrane and the basilar membrane, and even the round window membrane in some cases. The Reissner's membrane was found collapsed upon the end-organ, and this was thought to be responsible by pressure for degenerative changes in the end-organ and neural elements seen in the chronic experiments. There was no regularity of the site of damage in the end-organ in these animals in contrast to those animals exposed to gunshot and pure tone trauma where lower middle coil changes were most marked.

Wolff[15] observed extensive changes in the cochlea and neural elements of a riveter who had only a moderate high tone loss in the audiogram. A welder who had not complained of marked hearing loss was also found to have extensive pathology of the end-organ, with absence of Reissner's and tectorial membrane.

The clinical experiences relating to ear damage from shock pulses was considerable during the recent war.

In 1941, L. Holmgren, V. Nasiell, Key Aberg, Flodgren, Dohlman and F. Hagermann[16] participated in a symposium

on acoustic trauma in military operations. Extensive clinical experience was reported along with information on the relative merits of various protective devices. Hagermann and Holmgren were especially interested in the injury to the perceptive mechanism.

Murray and Reid[17] exposed subjects to gun blast and showed that inner deafness results without rupture of the drum. The stimulus was mild compared to what might be expected in action.

Machle[18] made similar studies on gunnery instructors and noted that recovery is not complete in 24 hours.

Hendricks[19] pointed out the variations in susceptibility to trauma in a group of machine gun instructors. No recovery was noted in the period between 15 to 130 days after exposure.

Hipskind[20] reviewed 170 cases of battle casualties and pointed out the lack of correlation between the degree of drum changes and the degree of hearing loss.

Craig[21] observed a considerable number of blast casualties with middle ear damage and all degrees of inner ear damage.

Suggit[22] examined 69 ears damaged by blast concussions. He saw all degrees of injury, including rupture of the drum. His audiometric studies pointed out the abrupt and gradual high tone loss features of the threshold curve in the nerve deafness in his cases.

Collins[23] reported his observations on casualties of the North African campaign. All degrees of middle ear damage were seen. Inner ear damage could not be clearly evaluated under conditions prevailing at the time. Wilcox and Schenck[24] reported on 82 cases of blast injury to the ear seen in the South Pacific theater. Greater hearing loss was observed in cases where the drum was not ruptured. Various degrees of severe inner ear damage were recorded with the audiometer.

Severe ear damage due to the shock pulse propagated under water to a subject with head immersed was described. The relatively confined medium of bodies of water will transmit a

shock impulse with less attenuation than air and, therefore, a greater potential danger is present in the waterborne shock pulse if the ear is immersed.

Korkis[25] analyzed 211 cases of drum rupture by blast in 167 soldiers wounded in the middle east and Italian campaigns. High explosives (shell) were most frequently responsible and the mixed deafness that resulted was studied with the audiometer.

The observations of Cope and Johnson[26] also indicate that severe nerve deafness can result from exposure to the shock pulses from many types of the smaller guns (30 and 50 calibre) without any apparent middle ear damage.

Reid[27] reported on the shock pulse trauma produced in the field and on the testing ranges. Both abrupt and gradual high tone irreversible losses were observed among the large number of subjects tested. Most of the damage appeared to develop in the first two years of exposure.

A significant portion of the population has been exposed to explosive sounds during the recent war. Many of the industrial noises are explosive in type. The significance of this type of noise in producing damage to the ear has long been recognized. Experimental evidence of this damage has been reported in animals and in man. Most of the experimenters have used stimuli that produced damage to the middle ear structures of the animal as well as to the cochlea. The use of stimuli that do not injure the middle ear is important in understanding the degree of damage to the inner ear that can be produced without middle ear damage. An examination of end-organ damage histologically has been limited in this special situation. The use of functional tests has been limited to observations on the pinna reflex. Besides the clinical significance of such ear injuries, any experimental procedures that can damage the inner ear are important from the standpoint of otologic research. There are a limited number of methods available to the otologist for producing various lesions of the labyrinth without entering the labyrinth spaces. Trauma with various types of sound stimuli is one of these methods. Pure

tone trauma has been of particular interest in attempting to understand the way the cochlea works. Shock pulse trauma has been usually produced by stimuli large enough to damage the conduction apparatus and cause widespread injury to the end-organ.

The physical phenomena associated with the production and propagation of pure tones have been well known for many years. The physics of short sound pulses created by explosive phenomena have not been well understood until recent years. With the development of the modern science and techniques of acoustics, a better understanding of the characteristics of the explosive sound has resulted. These exceedingly short disturbances have been accurately recorded and analyzed only in recent years. Their reaction upon the ear has been recorded.[25] The disturbance produced by an explosion is called a shock pulse. This pulse is characterized as being of exceedingly short duration, about 1/1,000 second, but this varies with the type of explosion, etc., and by being asymmetrical. The pressure changes during this period are very great as compared to the relatively small pressure changes associated with ordinary sound waves. The shape and duration of the pressure pulse is determined by the source. It may be relatively slow, 1/60 second, in reaching a peak or exceedingly abrupt, 1/100,000 second, and may last over a second or be over in 1/1,000 second. Not only is there a pressure rise corresponding to the positive pressure phase of an ordinary sound wave but also a longer phase of negative pressure follows this positive pressure. The reason why these stimuli usually affect the ear and produce an acoustic sensation is that their duration is within that to which the ear is normally made to respond. Stimuli lasting longer than 1/20 second, or less than 1/20,000 second, may react on the end-organ as well as on the conduction apparatus. Faster stimuli will probably produce no reaction in either part of the ear, while slower stimuli may react on the conducting mechanism alone by slow distortion, even to the point of rupture of the drum and disruption of the ossicular chain. These short pulses may produce a variety of acoustic sensations from a sharp crack to a dull boom, depend-

ing on these above mentioned physical characteristics. The frequency distribution of energy in such an asymmetrical pressure pulse can be determined by mathematical analysis with Forrier's method. In general, in the shorter and steeper pulse wave, there is a greater proportion of the total energy in high frequencies. In the longer and more slowly rising pulse, a greater proportion of the energy is contributed by low frequencies. The wave itself is propagated as a sound wave from one layer of molecules in the medium to the next layer. Near its source, the propagation is at a velocity greater than that for ordinary sound (*i.e.*, in air greater than 1,100 feet per second); furthermore, the reduction of intensity with distance from the source does not follow the inverse square law as for ordinary air sound source, but drops more rapidly than this near the source. Near the source, the pressure may be exceedingly high, but a relatively short distance away the pressure has dropped a great deal. Position of the ear with reference to the source is therefore very important.

The reaction of the ear to these asymmetrical short pulses is determined by the physical properties of the ear itself; that is, the stiffness, mass and damping or resistance of the various components of the ear will determine the nature of the resultant vibration. The pulse itself is highly damped (the pressure rapidly reduced to normal atmospheric pressure). The ear is also very highly damped. When the ossicular chain is displaced from a resting position, it returns to rest within about 1/700 of a second. The resonance frequency of the chain as recorded at the head of the malleus is about 700 cycles per second.[29] The drum itself appears to have a higher resonant frequency, since the amplitude of its movement is rather uniform for frequencies of constant intensity up to 3,000 cycles. The drum, therefore, may follow the exceedingly steep pressure front more faithfully than the ossicles. The induced oscillation recorded from the head of the malleus due to the shock pulse of a blank cartridge, 32 calibre, may last about 1/1,000 second and is asymmetrical. The period of oscillation, therefore, resembles that produced by an ordinary sound wave, and at the footplate the negative phase of the wave is considerably

greater. A stimulus is, therefore, transmitted by the footplate to the labyrinth fluid which moves the cochlear end-organ. The amount and location of this response is in part determined by the shape and height of the wave, so that an exceedingly brief pulse (1/5,000 second) might stimulate one portion of the end-organ, and with a longer pulse (1/100 second) another portion of the end-organ might be stimulated. The intensity of the wave corresponding to the height of the positive and negative pressures will determine the degree of end-organ damage. The shape of the pressure disturbance in the shock pulse in air is, therefore, modified by the physical properties peculiar to the ear itself. While the disturbances are brief, they are much more intense than that presented by ordinary sound sources. The ear is made to respond to pressure changes of a small fraction (less than 1/1000) of an atmosphere, while the pressure changes in a shock pulse may be several atmospheres.

The use of pure tones for experimental trauma is relatively easy, since they can be confined to small spaces and their physical characteristics can be controlled. Shock pulses are more difficult to use as a stimulus in the laboratory. An intensity great enough to produce damage but not enough to endanger the personnel and the life of the animal is needed. By experiment a suitable source was found. This was the shock pulse developed by a 32 calibre blank cartridge fired from a starting pistol at a distance of about one to two feet from the ear. In contrast to the firing of such a cartridge in an ordinary pistol, the pulse originating from a starting pistol leaves the cartridge holder directly — there being no barrel on the gun and, therefore, the pulse is not directional — but radiates more or less spherically. A pulse generated and directed through a gun barrel at an animal's ear can do a great deal more damage than is desirable.

The experiments were conducted in the following manner:

The bulla of the rabbit was exposed through a neck incision and perforated to give a view of the middle ear structures. An ear speculum was introduced through the neck incision to

fit snugly over the perforation of the bulla. Through this speculum, with the aid of a small hand lens and reflected light from a head mirror, the tensor tympani was visualized. The threshold for the acoustic contraction of the tensor was established by presenting pure tones through a loud speaker next to the operated ear. The tones were generated by a Western Electric 6B audiometer and fed into an amplifier, which in turn activated the loud speaker. The intensity at each frequency needed to produce a just visible contraction of the tensor when the tone was turned on and off suddenly was recorded. Care was exercised to avoid transient clicks in this procedure. This observation was repeated and the average reading taken as the threshold of response for the ear. The opposite ear in all acute experiments was destroyed by entering the bulla and knocking off the promontory. In some of the chronic experiments both ears were used.

After a threshold was established in most animals, the starting pistol was fired near the funnel of the speculum exposing the midle ear. This avenue of delivery of the stimulus was preferred instead of the external canal because it was more accurately controlled and more convenient than delivering the pulse through the external canal. The threshold of the acoustic muscle reflex was again determined for pure tones. This was repeated at intervals from a few minutes to several hours to study the acute changes in auditory function that results from this type of trauma. The animal was exposed to additional pulses if the first stimulus did not produce a recordable change in the threshold of the acoustic reflex response, or the pistol was fired nearer to the ear. After the experiment the animal was perfused and the temporal bone immediately excised and placed in fixing solution. The bones were prepared in the usual manner and sectioned serially.

In addition to the acute experiments, a comparable group of animals were operated under sterile conditions and tested before and after exposure to the shock pulse. The opposite cochlea was destroyed in some of these animals. Then the bulla and the neck wound were closed and the animal allowed to live for periods from three to 12 weeks. At the end of that

time the middle ear was again exposed, inspected and the threshold for the acoustic reflex was determined, after which the animal was perfused and the bones removed and prepared in a similar manner. Only animals that did not develop an infection were used.

FINDINGS.

Auditory Function: The relation between the threshold of auditory sensation in man and the threshold of reflex contraction of the stapedius muscle has indicated about a 60 db differential.[30] For conditions prevailing in the laboratory with a human subject at the same relative distance from the loud speaker, the equipment used showed a smaller differential between a just audible sound and a just visible acoustic contraction of the animal's tensor tympani. The reliability of this method for testing auditory function in animals has been pointed out.[31] A comparison between the human threshold for the sound generated in our experimental equipment and the acoustic threshold for the rabbit tensor reflex also indicated the relative sensitivity of this method for evaluating cochlear function. The maximum intensity of sound available for the different frequencies as measured on the decibel scale of the audiometer was far beyond that needed to produce just visible reflex contraction; therefore, a considerable range of sound intensity for most frequencies was available for exploration and detection of functional changes (see Fig. 1). The experiments were designed to produce a functional loss without visible damage to the middle ear and to produce partial to complete loss of auditory function as tested in this manner. This was done in order to throw light on the amount of functional and histologic change compatible with no visible damage to the conduction apparatus. It is this particular type of trauma that is more difficult to evaluate in man.

It was possible to produce partial loss of cochlear function as indicated by the tables, as well as complete absence of the reflex response to the maximum intensity available with the apparatus used (see Tables I to XI). Two acute reactions to trauma were observed. One was that of rapid recovery or a

return to the normal pre-exposed threshold. The other was progressive rapid deterioration of function during the short periods (up to two hours) that the animal was tested. The

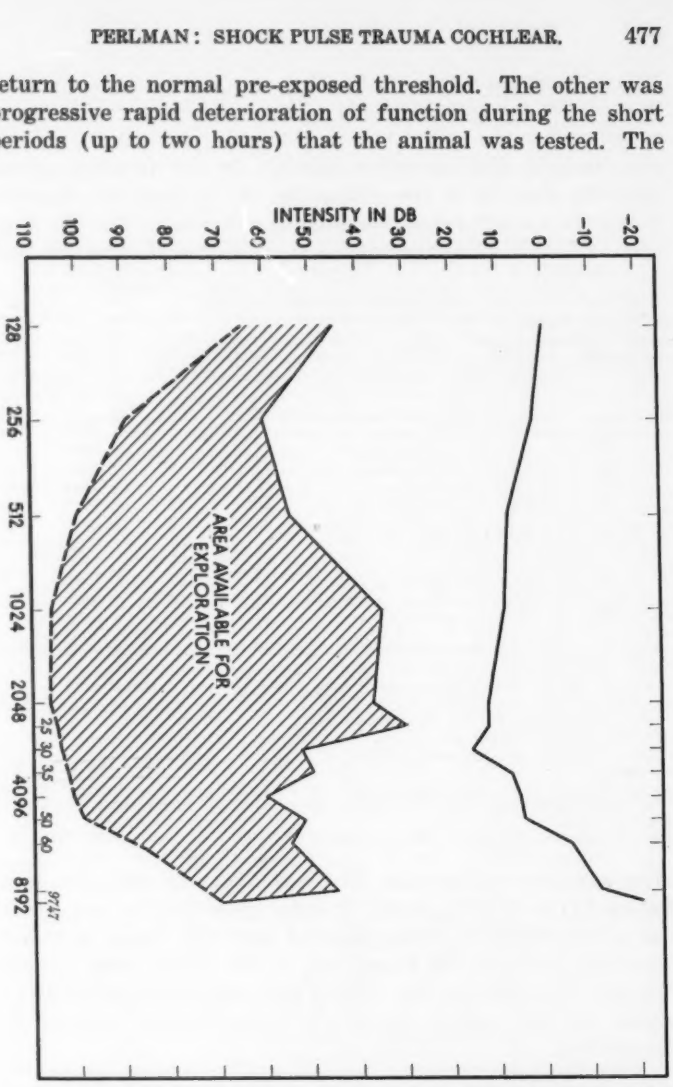

Fig. 1. Illustrating maximum readings on the audiometer (bottom line), the level at which a normal rabbit reflex response occurs (middle line) and the audiometer setting for just audible sound with the human subject near the loud speaker (top line). The shaded area represents the auditory field available for exploration of functional changes.

latter observation was unexpected and suggests that dissolution of the receptor elements of the end-organ may proceed rapidly after the initial injury. It is also evident from these observations that extensive damage to the function up to complete absence of the reflex can be obtained by exposing the ear to a shock pulse that leaves no visible middle ear damage. In the chronic experiments some degree of recovery even

TABLE I. RABBIT No. 10P.

	Right Tensor Reflex							
Frequencies	Loud Speaker Opposite Right Ear	After 1 Shot Opposite Right Ear	After 2 Shots	20 Min. Later	25 Min. Later	After 2 More Shots	After 2 more shots fired at mouth of funnel, with 5" of rubber tubing leading into perforation in the bulla	
128	50	65	50	—	50	—	max.	max.
256	67	70	70	—	70	—	max.	max.
512	75	72	75	—	72	—	max.	max.
1024	70	72	70	—	65	—	max.	max.
2048	45	50	45	—	50	42	75	104
2500	—	—	—	43	50	45	80	max.
3000	—	57	70	57	60	60	max.	max.
3500	—	—	—	55	57	60	max.	max.
4096	55	62	60	—	55	57	max.	max.
5000	—	60	62	—	50	60	max.	max.
6000	57	55	83	—	50	50	max.	max.
							after 15 minutes	

Threshold of acoustic reflex before and after exposure to shock pulses.

Max. = no response to maximum intensity available with the system.

High tone loss at 3,000 and 6,000 cycles with recovery is seen after two shots, and almost complete loss of response after six shots.

The drum and ossicular chain are intact.

There is some blood on the external surface of the drum, probably an artefact, and on the tensor tendon.

Torn Reissner's in middle of the first coil, very little to see in cochlear duct otherwise, except minimal changes in the outer hair cells of the second coil and blood against the basilar membrane.

The amount of functional loss is out of proportion with the histological changes.

after complete obliteration of the reflex was observed (see Tables XII to XXIV), while in some cases further deterioration of function was noted. Isolated high tone losses were not observed. Prior to the experience of the recent war, it was customary to consider that in man only pulses that injured the middle ear were apt to produce profound loss of function in the cochlea.

Ruedi and Furrer have pointed out the error in this concept and the importance of the shape of the pulse, as well as the pressure, in accounting for middle ear damage.

Histological examination revealed various degrees of damage in the cochlear duct and the corresponding nerve elements. The rabbit cochlea has only two complete turns and the damage was usually confined to the upper part of the first turn

TABLE II. RABBIT No. 11P.

Left labyrinth destroyed.

	Right Normal Reflex	One Shot, 6" from Funnel	15 Minutes Later
128	45	No response at maximum	No response at maximum
256	60	No response at maximum	No response at maximum
512	55	No response at maximum	No response at maximum
1024	35	No response at maximum	No response at maximum
2048	37	No response at maximum	No response at maximum
2500	30	No response at maximum	No response at maximum
3000	53	No response at maximum	No response at maximum
3500	50	No response at maximum	No response at maximum
4096	60	No response at maximum	No response at maximum
5000	52	No response at maximum	No response at maximum
6000	55	No response at maximum	No response at maximum
8192	45	No response at maximum	No response at maximum
9747	70	No response at maximum	No response at maximum

Threshold acoustic reflex in db on Western Electric audiometer before and after exposure to the shock pulse. Note: Complete obliteration of the response without recovery. The conduction apparatus is intact. There is some blood in the middle ear. Damage to the end-organ and stria vascularis in upper part of second coil is clear. The disruption of Reissner's membrane in the upper part of the first turn may be artefact. Definite functional loss could be expected, but not complete obliteration of response.

TABLE III. RABBIT 12P.

	Normal Curve of Left Tensor	After 1 shot, approximately 2 ft. away—funnel and rubber tubing in outer canal	35 minutes later	60 minutes later
128	45	50	50	50
256	65	75	65	67
512	65	74	66	69
1024	50	70	57	60
2048	37	55	47	50
2500	25	40	35	40
3000	35	55	45	47
3500	30	54	45	42
4096	42	55	45	52
5000	40	57	50	50
6000	35	40	40	45
8192	42	55	55	50
9747	37	Responds to click at maximum of 70	45	45

Right labyrinth destroyed.

Threshold of acoustic reflex, before and after exposure to a shock pulse conducted through the external canal.

Note rather widespread partial loss with recovery.

No histological evidence of end-organ damage.

and the lower part of the second turn. Ruedi and Furrer have found similar damage in their experiments and contrasted this type of damage they produced by detonation of a gun from that produced by exposing animals to shock waves from relatively large amounts of explosives. In the latter twpe of injury, rupture of Reissner's membrane and subsequent collapse of this membrane upon the organ of Corti was found along with extensive middle ear damage. The collapsed Reissner's membrane was thought to produce, by pressure, the hair cell and neural damage observed in animals sacrificed some time after exposure. They differentiated the pulse from the

TABLE IV. RABBIT No. 13P.

	Normal Curve, Right Tensor	1st Shot, 2 Ft. Away, into Spec. in Bulla	2nd Shot, 30 Min. Later, 1 Ft. Away Spec. in Bulla	Readings 1 Hr. Later
128	35	37		
256	55	60		
512	53	53		
1024	35	40		
1200	37	—		
1500	30	—		
1800	30	—		
2048	30	40		
3000	55	60		
4096	52	55		
5000	45	57		
6000	45	60		
8192	50	60	No response at maximum	No response at maximum

Acoustic reflex threshold, before and after to exposure to two shock pulses.

Note: Partial loss at 6,000 cycles after one pulse and complete obliteration of response after the second pulse. Definite end-organ damage most marked in the lower part of the second coil would suggest a definite functional loss. There was damage to the stria vascularis in the same region of the cochlear duct. The complete obliteration of the reflex response suggests wider end-organ damage than can be definitely seen in the microscope.

discharge of a gun from that from a large amount of explosive on the basis of the pressure to time relationship of the positive and negative wave of the disturbance. The former had shorter time periods.

In the chronic experiments several observations are noteworthy. Once the reflex was obliterated, evidence of return of function was observed in only one animal. Lesser degrees of functional loss was often followed by recovery. The degree of damage in the cochlea was more extensive than one would

TABLE V. RABBIT No. 14P.

Frequency	Normal	Left Tensor Readings 1st Shot, 2 Ft. Away	2nd Shot, 2 Ft. Away	3rd Shot	10 Min. After 3rd Shot	4th Shot, 1½ Ft. Away	5th Shot, 1 Ft. Away	6th Shot, 6 In. Away	10 Min. Later	20 Min. Later
128	37	—	—	—	40	—	—	40	—	40
256	60	—	—	—	60	—	—	65	—	60
512	65	62	—	—	65	—	—	70	—	70
1024	50	55	—	—	60	—	—	65	70	65
2048	50	45	—	60	45	40	40	60	60	57
3000	57	55	—	60	60	55	55	65	70	80
4096	55	85-65	97-70-62	77	80-57	65	60	max.	70-65	max.
5000	60	60	80-60	70-max.	70	Max. 65-75-60	75	max.	max.	max.
6000	55	55	—					max.	max.	max.

Reaction after a series of shock pulses.

Note: Thresholds at 4,096 and 5,000 cycles are recorded at a few minute intervals to show depression and rapid recovery of response at beginning and final continued loss above 3,000 cycles. No definite histological changes in end-organ. Good function would be anticipated, but the high tone loss is not reflected in the histological picture.

anticipate from analysis of the findings in the acute experiments. More clear-cut and widespread damage was produced when the animal was allowed to live long enough for clear-cut degenerative changes to take place. The stria vascularis was

TABLE VI. LEFT TENSOR READING OF RABBIT No. 15P.

Frequency	Normal	1st Shot, 2 Ft. Away	After 1 Hour
128	40		
256	60		
512	55		
1024	45	No response	No response
2048	33		
3000	40		
4096	45		
5000	35		
6000	35		
8192	35		
9747	35		

Right labyrinth destroyed. Shot fired near speculum into bulla.

Note: Complete obliteration of response after exposure to one pulse. Clear-cut histological picture of disruption of the outer hair cells in the upper half of the first turn in the cochlea. The degree and location of histological change would suggest profound loss as was found in this animal.

TABLE VII. LEFT TENSOR, RABBIT No. 16P.

Frequency	Normal (Before Shot)	1st Shot, 2 Ft. from Speculum	20 Min. After 1st Shot	45 Min. Later
128	40	No response No response—	A response at maximum 62	
256	62	87	70	
512	62	75	72	
1024	50	70	70	
2048	50	65	60	
3000	45	65	65	
4096	52	70	65	No response
5000	40	55	60	
6000	40	50	55	
8192	No response	No response	No response	

Right cochlea destroyed. Acoustic reflex threshold after one shot.

Note: Lower and middle frequency loss immediately after exposure, followed by complete obliteration of response. Small degree of histological damage confined to the outer hair cells of a small area in the lower part of the second turn. Along with shattering of stria in this region. Complete loss of response would not be expected. The degree and location of damage is different from that seen in Rabbit 15. The conduction apparatus appears negative.

damaged in portions of the cochlear duct. Degeneration of the neural elements to and beyond the spiral ganglion took place, along with degeneration of the ganglion cells themselves.

ACUTE INJURIES.

Various degrees of trauma to the end-organ have been recognized. They are listed by Lurie in order of their severity as follows:

1. Change in the protoplasm of the external hair cells.

TABLE VIII. LEFT TENSOR, RABBIT No. 17P.

Frequency	Normal	1st Shot	15 Min. Later	30 Min. Later
128	35	63	No response at maximum	No response at maximum.
256	60	75	87	
1024	40	70	70	
2048	33	60	65	
3000	32	63	63	
4096	50	70	65	
5000	33	55	60	
6000	33	50	55	
8192	35	No response at maximum	No response at maximum	
9747	35	No response at maximum	No response at maximum	

Threshold of acoustic reflex after trauma with one shock pulse. Note widespread loss of response immediately after exposure, followed by complete obliteration of response 30 minutes later, indicating a progressive damage to the ear.

Definite lesion of end-organ — particularly at upper end of first turn and lower end of second turn of the cochlea, but rather widespread; would suggest profound functional loss.

TABLE IX. RABBIT No. 18.

Frequency	Normal	1st Shot, 3 Ft. Away from Bulla	15 Min. Later	2nd Shot	15 Min. Later	20 Min. Later
128	37	40	40	40	45	Not at max.
256	57	62	60	62	70	Not at max.
512	60	62	65	72	72	80
1024	47	55	57	60	70	90
2048	33	37	37	45	50	70
3000	45	55	55	60	65	85
4096	60	62	55	55	60	Not at max.
5000	42	50	42	50	55	Not at max.
6000	40	40	40	45	50	Not at max.
8192	45	45	45	50	55	Not at max.
9747	40	45	60	Not at max.	Not at max.	Not at max.

Threshold of response of the reflex acoustic contraction of the tensor tympani muscle before and after trauma with a shock pulse. Note: No effect from first shot, a middle frequency change after the second shot, which progressed to a widespread, severe drop in 20 minutes. No histologic lesion of end-organ except questionable outer hair cell damage in a limited area of second coil. The cochlea is not cut in a proper plane to permit careful evaluation. The amount of functional loss appears out of proportion to the histologic changes.

2. Disruption of the mesothelial cells under the basilar membrane.

3. Disruption of the external hair cells.

TABLE X. LEFT TENSOR READINGS, RABBIT No. 19P.

Frequency	Normal Curve	1st Shot, 3 Ft. Away	30 Min. After 1st Shot
128	37	45	No response at max.
256	55	65	No response at max.
512	65	70	No response at max.
1024	55	67	103
2048	45	60	103
3000	40	50	100
4096	55	75	
5000	45	60	No response at max.
6000	47		No response at max.
8192	No response	No response at max.	No response at max.
9747	45		

Damage to the ear as reflected in the threshold of the acoustic middle ear reflex — showing widespread partial loss immediately after exposure, proceeding to profound loss in 30 minutes.

The end organ is not damaged, but there is a tear in the drum with fracture of the handle of the malleus and of the footplate of the stapes. The poor response is probably due to the conduction lesion.

TABLE XI. LEFT TENSOR READINGS, RABBIT No. 20P.

Frequency	Normal Curve	1st Shot, 3 Ft. Away from Speculum	50 Min. Later
128	37	No response at maximum	No response at maximum
256	55		
512	55		
1024	45		
2048	45		
3000	50		
4096	45		
5000	50		
6000	40		
8192	40		
9747	60		

Ear damage from one shock pulse as reflected in the acoustic tensor tympani response. Definite end-organ damage at upper end of first turn and beginning of second turn, and blood in scala tympani against basilar membrane. Histological findings would suggest profund functional loss.

4. Separation of the organ of Corti from the basilar membrane or a break in the continuity of the organ.

5. External hair cells and Deiter's cells lifted or thrown off the basilar membrane.

6. Internal pillar cells, internal hair cells, cells of Claudius remain after break in continuity of the reticular membrane

TABLE XII. RABBIT No. 21P.

Frequency	1	2	3	4	5	6
	L	L	L	L	L	L
128	45	55	50	—*	—	45
256	63	70	70	75	80	55
512	60	75	70	85	80	58
1024	47	55	60	70	70	55
2048	35	43	50	65	60	45
3000	45	55	60	80	70	40
4096	45	60	60	70	75	50
5000	40	55	55	65	65	50
6000	40	55	55	—	—	40

*Dash (—) represents no response at maximum intensity.

After exposure to one pulse at three feet, only slight loss of function is noted. (Col. 2) with no signs of recovery in 15 minutes (Col. 3). A second pulse at two feet produces a more noticeable partial loss (Col. 4), with no evidence of recovery after seven minutes (Col. 5). After 13 weeks there is apparent complete recovery with return to the pre-exposed threshold (Col. 6). The right labyrinth was destroyed at the beginning of the experiment.

Left outer hair cells in lower half of second turn with nerve fibres are definitely pathological, but for a very limited area. Right (fractured side) shows labyrinth hydrops with degeneration of the stria. The end-organ and nerve apparatus look good throughout right ear. There is fibrosis of the saccular wall at site of perforation with the needle.

The needle fractured the promontory and the bony septum between the middle coil and vestibule, tearing the saccule. The relatively limited and minimal change to the end-organ and nerves of the left ear in the lower half of the second coil may account for the good functional test obtained in this animal more probably than the right ear changes being limited to the stria, Rejssner's membrane and the saccule.

TABLE XIII. RABBIT No. 22P.

Frequency	1	2	3
	L	L	L
128	47	—	45
256	63	—	60
512	67	—	67
1024	47	—	75
2048	47	—	64
3000	40	75	70
4096	50	—	—
5000	50	—	—
6000	40	—	—
8192	35	—	—
9747	30	—	—

After exposure to one pulse, the response was obliterated for all frequencies except 3,000 cycles, which was impaired. Col. 2. The normal left tensor threshold before exposure is recorded in Col. 1. Eleven weeks later, recovery for the low frequencies has occurred, while high frequency involvement continues with only a slight recovery (Col. 3). The right labyrinth was destroyed at the beginning of the experiment and shows an obliterative labyrinthitis. The outer hair cells of the left cochlea are widely damaged in lower half of the second and the upper half of the first coil, but there are no nerve fibre or ganglion cell changes. These widespread outer hair cell changes in the left ear are to be related somehow to the high tone loss in function.

over the external hair cells allows this protoplasm and the Deiter's cells to ooze out through the break.

7. Complete disappearance of the organ of Corti from the internal sulcus cells to the Claudius cells, or just the internal pillar cell and internal hair cell remains.

TABLE XIV. RABBIT No. 23P.

Frequency	1	2	3	4	5	6
	L	L	L	L	L	L
256	70	70	70	60	—	57
512	70	75	65	65	—	65
1024	65	65	65	70	—	67
2048	45	45	45	60	70	65
3000	70	65	65	65	55	85
4096	55	65	60	60	65	—
5000	55	—	—	—	90	—

After exposure to one pulse only, a high tone loss is suggested (Col. 2) that continued, and after exposure to a second pulse (Col. 4), a low tone loss was noted even after 60 minutes (Col. 5). Seven weeks after exposure, only the high tone loss (above 2,000 cycles) remained.

The right labyrinth was destroyed at the beginning of the experiment. Outer hair cells in lower part of second coil of the left ear are pathological but the nerve fibres and ganglion cells are intact throughout. The degeneration of the stria is widespread in the right or fractured side but the nerve structures are not changed. The outer hair cells in part of the second coil of the right ear appear abnormal. The high tone loss is probably the expression of the function of the left cochlea, but the limited minimal pathology in the second coil is all that can be seen to explain this.

TABLE XV. RABBIT No. 24P.

Frequency	1	2	3	4
	R	R	L	L
256	70	—	90	—
512	65	85	80	—
1024	40	60	75	—
2048	30	—	60	—
3000	25	45	65	—
4096	15	50	40	—
6000	20	45	—	—
8192	25	—	—	—
9747	25	—	—	—

Response of right ear before and and after exposure to one pulse (Cols. 1 and 2). Similar experiment on left ear (Cols. 3 and 4). Animal died five days later.

With the exception of the change in the mesothelial cells under the basilar membrane, all the above changes can be seen in this group of animals exposed to minimal blast trauma. It may be pointed out that the very delicate nerve fibres crossing the tunnel of Corti and Nuel's space may be injured or disrupted without injury to the other cell structures of the end-organ. Such injury might produce nerve fibre degeneration without other signs of end-organ damage.

In addition, disruption of the stria vascularis is also evident. In two instances the basilar membrane and Reissner's membrane appeare to have been torn. Lesions appear to be limited in most cases to the middle of the cochlear duct and

TABLE XVI. RABBIT No. 25P.

Frequency	1	2	3	4	5	6	7	8	9
	R	R	L	L	R	L	L	L	R
128	55	—	50	—	—				
256	70	70	65	—	75				
512	65	70	65	50	75			85	
1024	40	60	50	80	65			95	
2048	30	45	30	60	45			80	
3000	25	30	35	55	50			50	
4096	25	40	30	55	45	No response	No response	95	No response
6000	15	45	30	45	80			—	
8192	35	—	50	—	—			—	
9747	35	—	60	—	—				

Threshold changes in right ear before and after exposure to one pulse (Cols. 1 and 2). Similar experiment on left ear (Cols. 3 and 4). Col. 5, response of right tensor after second pulse. Col. 6, similar experiment on left ear with no immediate return of function (Col. 7). One month later the left tensor threshold is greatly depressed and the right is obliterated (Cols. 8 and 9). Dash indicates no response at maximum output of sound equipment. There is extensive change in the organ of Corti on the left side along with nerve fibre degeneration up to the ganglion in the upper half of the first and in the lower half of the second coil. The outer hair cells in the middle of the first coil are pathological but there is no nerve fibre change to be seen. On the right side there is outer hair cell damage through the lower half of the middle coil. Definite loss of function is to be expected from the histological changes, but more from the left than from the right.

TABLE XVII. RABBIT No. 26P.

Frequency	1	2	3	4	5
	L	L	R	L	R
256	65	No. R.	No. R.	No. R.	
512	70	95	No. R.	85	
1024	55	100	85	70	
2048	45	95	70	50	
3000	20	60	65	60	
4096	30	80	70	—	
6000	20	No. R.	No. R.	—	No response
8192	30	No. R.	No. R.	—	
9747	30	No. R.	No. R.		

Good left tensor response before exposure to one pulse at 12 inches. (Col. 1), definitely raised after exposure (Col. 2) and affecting right ear also (Col. 3). One month later some recovery is noted in the left tensor threshold and the right shows no response for the sound intensities available. External hair cells in lower half of second coil damaged, with beginning nerve degeneration in left ear. Right ear shows external hair cells in the middle of the first coil damaged, but no nerve degeneration.

various degrees of damage about an area of maximum pathology could be demonstrated. The animals that lost their acoustic reflex response all showed clear-cut but limited coch-

TABLE XVIII. RABBIT No. 27P.

Frequency	1	2	3	4	5
	L	L	R	L	R
256	75	No response	No response	No response	No response
572	75				
1024	55				
2048	50				
3000	50				
4096	45				
6000	40				

Tensor response completely obliterated from both ears after exposing left ear to one pulse (Cols. 2 and 3). No return of response was noted after one month (Cols. 4 and 5).

There is widespread end-organ damage, particularly to external hair cells, in most of the first and in the lower half of the second coil on both sides. There is also limited nerve fibre degeneration in this area up to the ganglia.

TABLE XIX. RABBIT No. 28P.

Frequency	1	2	3	4	5	6	7	8	9
	L	L	R	L	R	R	R	L	R
256	80	No response	65	75	70	No response	No response	No response	No response
512	75		70	75	70				
1024	65		55	60	60				
2048	55		50	40	50				
3000	55		40	40	40				
4096	50		30	55	45				
6000	50		40	50	45				

Immediately after exposure of left ear to one pulse, no tensor reflex could be elicited on that side (Col. 2). Then the right tensor was tested (Col. 3) and good function observed. (Col. 4) represents the left tensor threshold five minutes later indicating recovery. The right ear was now exposed to one shock pulse after an initial threshold reading (Col. 5) and this tensor reflex was obliterated (Cols. 6 and 7). One month later, no response could be obtained from either tensor. The lower half of the right and left second coils show both pathology in the end-organ and nerve fibre degeneration, while outer hair cell damage extends into first turn. In the first coil on the right there is a spectacular cyst of the stria vascularis. Profound functional loss is to be expected with the clear-cut damage in both right and left sides.

TABLE XX. RABBIT No. 29P.

Frequency	1	2	3	4	5	6	7	8
	L	L	L	L	R	R	R	L
256	65	70	70	No R.	70	85	No R.	85
512	75	70	75	85	70	80	95	70
1024	50	55	65	75	70	75	85	65
2048	45	50	55	65	45	55	70	55
3000	35	45	45	50	45	50	70	50
4096	50	50	45	55	50	55	80	45
6000	40	55	40	50	35	50	60	40

Threshold before (Col. 1) and after (Cols. 2, 3, 4) exposure of left ear to one pulse suggested a small depression of function with some recovery after one month (Col. 8). Immediately after exposure of the right ear to one and 2 pulses (Cols. 5 and 6) the threshold on that side was not appreciably changed, but one month later further loss is suggested (Col. 7).

The hair cells and nerve fibres to the end-organ through the middle and upper basal coil on the right, and through the upper half of the middle coil on the left, are pathological, but the rest of the cochlear duct is apparently not damaged. The limited degree of functional loss is surprising when compared to other animals, but might be explained by the limited lesion of the upper middle coil in the left cochlea.

TABLE XXI. RABBIT No. 31 P.

Frequency	1	2	3	4	5	6
	R	R	L	L	L	R
256	80	80	70	No R.	No R.	No R.
512	70	75	70	95	85	80
1024	55	75	60	85	75	75
2048	40	60	50	65	75	60
3000	35	50	35	60	55	60
4096	40	55	45	70	55	60
6000	35	65	60	No R.	No R.	No R.

Cols. 1 and 2, threshold of right tensor before and after exposure of right ear to pulse at nine inches. Exposure of left ear (Cols. 3 and 4) shows generalized depression of function similar to that seen in the right ear. This has not changed appreciably 19 days later (Cols. 5 and 6).

TABLE XXII. ANIMAL No. 32P.

Frequency	1	2	3	4	5	6
	L	L	R	R	L	R
128	No R.	No R.	No R.	No R.	No R.	
256	No R.	No R.	95	No R.	80	
512	85	No R.	80	No R.	75	
1024	80	No R.	75	No R.	75	
2048	No R.	65	60	No R.	50	
3000	60	95	50	No R.	60	
4096	70	95	50	No R.	40	
6000	No R.	No R.	60	No R.	No R.	
8192	No R.	No R.	No R.	No R.	No R.	
9747	No R.	No R.	No R.	No R.	No R.	

No response

Threshold of left tensor immediately after exposure to one pulse (Col. 1) and 2 pulses (Col. 2). Note general and cumulative depression of function. Cols. 3 and 4 show result of similar exposure of right ear with complete obliteration of tensor response. Cols. 5 and 6 show the tensor threshold of L and R ear, respectively, 20 days later with sound delivered near the tested ear. Some recovery has taken place in the function of the left ear, but not of the right ear. The left cochlea was accidentally cut away when trimming the celloidin block, leaving only the semicircular canals and a portion of the vestibular and cochlear nerve trunks in the internal meatus. No pathology was seen in these parts of the ear. The end-organs in the right labyrinth are within normal limits. There was some evidence of drum damage which might account for the loss of the tensor reflex for air conducted sound.

TABLE XXIII. RABBIT No. 33P.

Frequency	1	L	3	4	5	6	7
	L	2	R	R	R	L	R
256	85	No R.	75	No R.	No R.	75	85
512	80	No R.	75	95	No R.	75	75
1024	75	No R.	75	85	100	70	65
2048	65	80	50	65	70	55	50
3000	60	80	70	65	85	60	60
4096	60	No R.	65	80	90	40	50

Threshold of left tensor after one pulse (Col. 1) and after two pulses (Col. 2). Threshold of right tensor before (Col. 3) and after one pulse (Col. 4) and after two pulses (Col. 5). Note general depression of function. Cols. 6 and 7 show the function of the left and right tensor, respectively, 20 days later. Note evidence of recovery of function. Good end-organ throughout both ears.

lear lesions in this area except one in which the conduction apparatus was damaged. The animals showing only a partial loss of the acoustic reflex response of the tensor tympani muscle did not show a clear-cut end-organ change. Conversely, using conditioned cats, Neff[32] has shown that a large part of the fibres of the cochlear nerve (up to 50 per cent) may be destroyed without producing an appreciable functional loss in hearing up to 8,000 cycles.

It appears from an analysis of this material that small changes in auditory function may show little evidence histologically in the acute state; furthermore, the profound loss of

TABLE XXIV. RABBIT No. 33P..

Frequency	1	2	3	4	5	6	7	8	9
	L	L	L	R	R	R	R	R	L
256	70	80	80	75	70	75	75	—	75
512	75	75	75	75	75	75	75	80	75
1024	65	65	70	70	70	65	70	75	75
2048	50	55	55	55	50	50	50	70	60
3000	40	50	55	45	45	45	45	60	50
4096	40	50	55	40	40	40	45	60	50
6000	30	50	60	35	45	45	44	50	55

Cols. 1, 2 and 3. Left tensor threshold before (1) and after (2 and 3) exposure to three shock pulses — showing little effect except at 6,000 cycles. Cols. 4, 5, 6 and 7 — similar exposure of right ear, showing no immediate effect. Cols. 8 and 9; threshold of right and left ear, 21 days later. A small degree of auditory loss for the high frequencies, from 2,048 to 6,000 in the right and 6,000 cycles in the left ear, is suggested. Middle coil changes in the left cochlea are extensive, including end-organ, nerves and ganglion. The basal coil remains in good condition. The right cochlea appears within normal limits throughout. This probably accounts for the good function obtained from the acoustic muscle reflex in both sides since the reflex is a crossed response. The left cochlea was exposed to three shock pulses, while the right cochlea was exposed to two pulses.

function as tested with the acoustic reflex response is out of proportion with the limited degree of end-organ damage seen in the microscope. More subtle changes in the end-organ, over a wide area not discernible in the microscope, are probably present and are responsible for the profound functional changes observed. From these experiments it is evident that definite end-organ damage and profound functional loss can be produced with pulses that do not damage the conduction apparatus. It is, therefore, reasonable to expect clinical examples of severe depression of auditory function with no visible middle ear damage in human subjects exposed to even one shock

pulse. A pulse comparable in intensity and shape to that created by a 32 calibre blank cartridge fired from a starting piston (not having the directional characteristics of one fired from a gun barrel) and close to the ear (within about 12 inches) may be adequate to produce this clinical picture.

SUMMARY.

Functional Loss: Exposure of the ear to relatively weak shock pulses that do no gross damage to the conduction apparatus can produce definite loss of auditory function as tested by the acoustic reflex response of the tensor tympanic muscle.

The sound intensity presented by this pulse is apparently much greater than the ordinary continuous sound source, since the latter type of sound source near the threshold of feeling is not sufficient to produce any appreciable change in the threshold of the acoustic middle ear muscle reflex even after 45 minutes' exposure.[33] The shock pulse, on the other hand, is sufficiently intense to obliterate the reflex for the sound intensities available.

In these animals showing a partial loss, no uniform predilection for the high frequencies was noted, but high frequency loss was often produced. In these animals with a high frequency loss, an isolated dip in the 4,000 cycle region was an exception.

Two acute functional reactions were observed: one was the evidence of recovery of function from within a few minutes to several hours after exposure; the other was a rather rapid progressive obliteration of function within a few minutes after the immediate postblast threshold was taken.

Complete obliteration of the reflex response could be obtained frequently with the stimulus used and without injury to the conduction apparatus. Partial recovery of function was seen in some of the chronic experiments, and in one animal even after complete obliteration of the reflex response.

The interpretation of functional losses in some of the chronic experiments is handicapped by the preservation of

both ears, each of which was traumatized individually but not to the same degree. Since the acoustic response of the middle ear muscles is a crossed reflex, the function of the better ear is often being tested regardless of precautions used to deliver the sound near the ear being tested while covering the opposite ear.

Histological Damage: With one exception, no significant damage was seen in the conduction apparatus.

All degrees of end-organ damage were observed, from minimal changes in the outer hair cells to disruption of the entire organ of Corti through a limited area. Shattering of the stria for a limited area adjacent to the greatest end-organ damage was also seen, but gross damage to Reissner's membrane and the basilar membrane was seen in only one case. The greatest damage to the end-organ was usually near the middle of the cochlear duct near the upper end of the basal coil (see Figs. 2, 3, 4 and 5A).

In the chronic experiments, the changes were more striking and more extensive. They include complete degeneration of the organ of Corti and various degrees of nerve fibre and ganglion cell change. The changes occurred in the fibres leading from the end-organ to the ganglion, and in some animals the ganglion and the nerve fibres beyond it also showed definite changes. Some changes in the stria vascularis were also produced (see Figs. 5B, 6, 7 and 8).

Correlation between functional change and the histological findings: There is no clear-cut relation between the partial loss of function and the position of the histologic lesion in the end-organ, whether this functional loss was widespread or when it was more marked through the upper and lower frequencies. The more widespread and severe the histological damage was usually associated with the most severe functional loss, but complete obliteration of the reflex response was noted when only a limited histological lesion was seen. The greatest trauma was usually in the upper end of the basal coil (near the middle of the cochlear duct). The preservation of a histologically good end-organ through a large portion of the

basal coil is difficult to reconcile with a high tone loss in function, except that the upper limit of hearing for the animal is probably far beyond 9,000 cycles. There is also a disparity

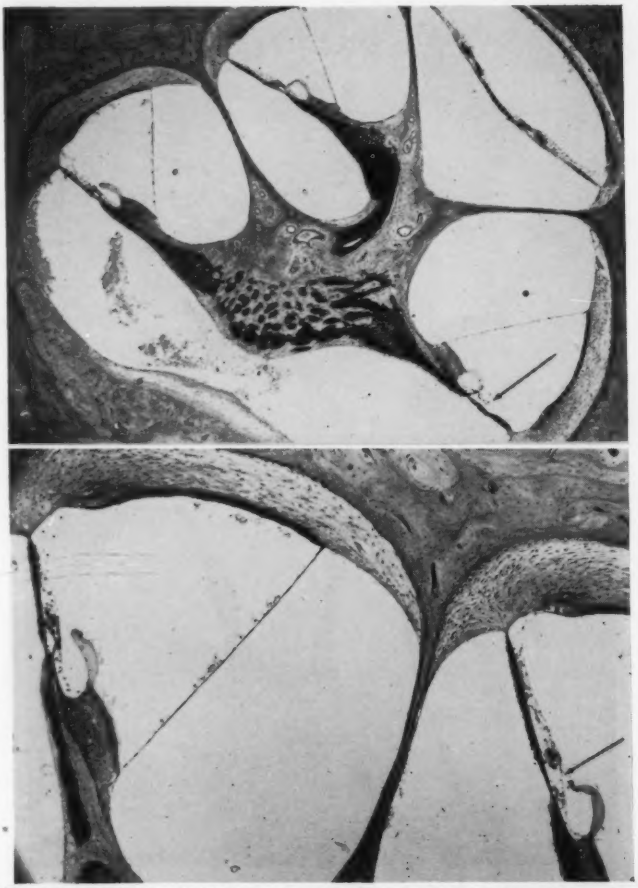

Fig. 2A. Left ear. Rabbit 17. Dissolution of the end-organ, upper basal, beyond the internal pillar. There was complete obliteration of the acoustic reflex response of this ear (see Table VIII).

Fig. 2B. Left ear. Rabbit 17. Dissolution of the pillar cells — lower end of second coil. Acoustic reflex obliterated (see Table VIII).

between the low tone losses and the appearance of the end-organ in the upper part of the cochlea.

The experimental findings in general do not contribute any

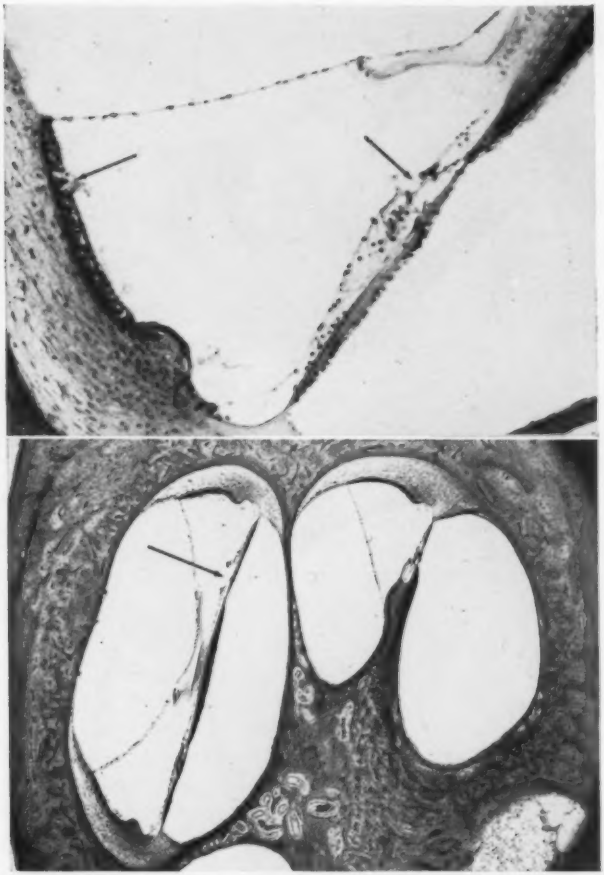

Fig. 3A. Rabbit 13. Left ear. Dissolution of outer hair cells — lower part of second coil. Complete less of acoustic reflex of tensor tympani (see Table IV).

Fig. 3B. Rabbit 13. Left ear. Partial dissolution of reticular membrane of the organ of Corti and of the stria vascularis, lower part of second coil (see Table IV).

evidence for localization of the response in the organ of Corti for the frequencies and the intensities used in this experiment for producing the reflex contraction. The difference in sensitivity between auditory threshold and the muscle reflex thresh-

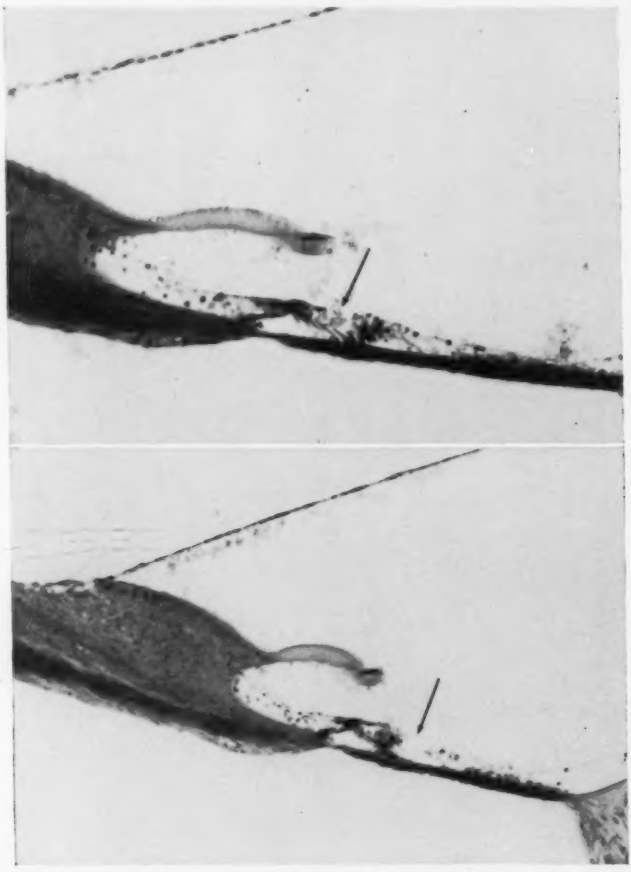

Fig. 4A. Rabbit 20. Left ear. Outer hair cells disrupted upper half of basal coil. Acoustic reflex obliterated (see Table XI).

Fig. 4B. Rabbit 20. Left ear. Disruption of Hensen and Deiter's cells in upper half of basal coil. Acoustic reflex was obliterated (see Table XI).

old has been explained by assuming a different locus of stimulation (outer hair cells and inner hair cells, respectively), but may be due to a wider locus of stimulation of the whole end-organ. In any case, complete obliteration of the acoustic reflex

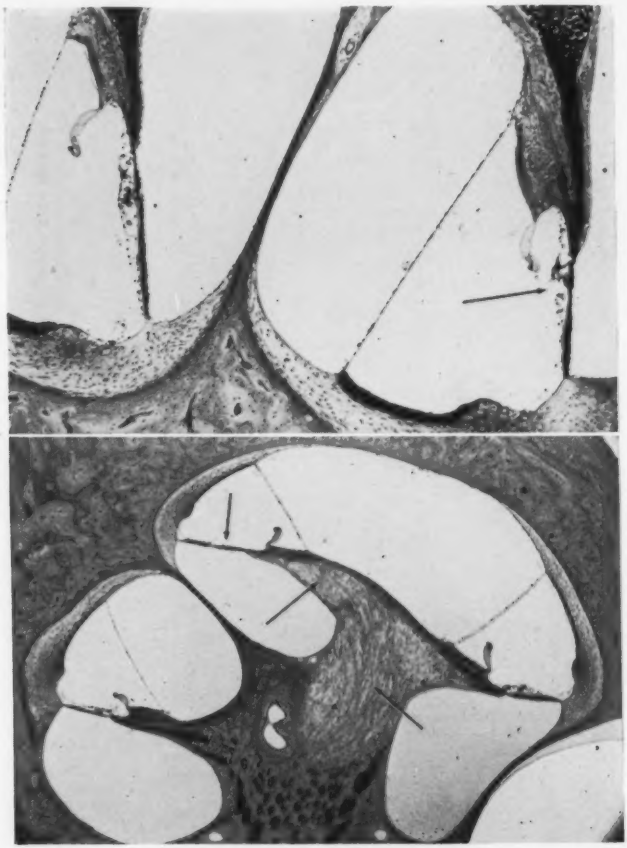

Fig. 5A. Rabbit 15P. Left ear. Dissolution of outer hair cells in basal turn. Acoustic reflex obliterated. Acute injury.

Fig. 5B. Rabbit 34. Left ear. Twenty-one days after exposure. Widespread, severe degeneration of end-organ, nerves and ganglion cells except in lower end of basal turn. Good reflex response attributed to good right cochlea (see Table XXIV).

is compatible with the preservation of some auditory function. The fact that in these experiments the inner hair cells were usually spared and at most damaged over only a limited area

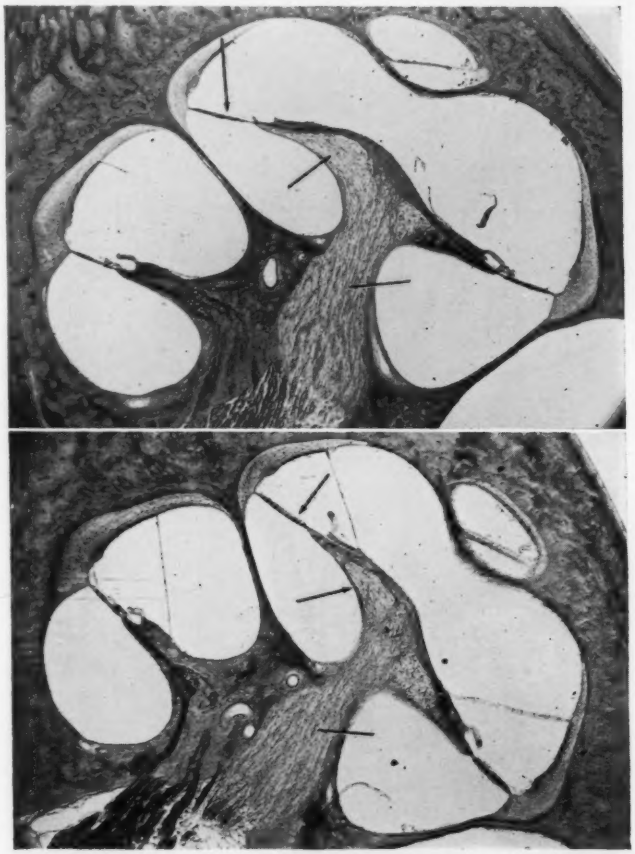

Fig. 6A. Rabbit 31. Left ear. Nineteen days after exposure. Above the first turn there is severe degeneration of the end-organ; nerve fibres central and distal to the ganglion, and the spiral ganglion. Only a questionable high frequency loss of the acoustic reflex was recorded, probably because of the normal appearing basal coil (see Table XXI).

Fig. 6B. Rabbit 31. Right. Nineteen days after exposure. Nerve fibres and organ degeneration in second coil is marked. The disruption of Reissner's membrane is probably real and extends to the basal coil. Only partial loss of the acoustic reflex was noted (see Table XXI).

through the middle of the cochlear duct, suggests that the reflex response is not dependent on this particular part of the end-organ. The threshold of the pinna reflex is higher than

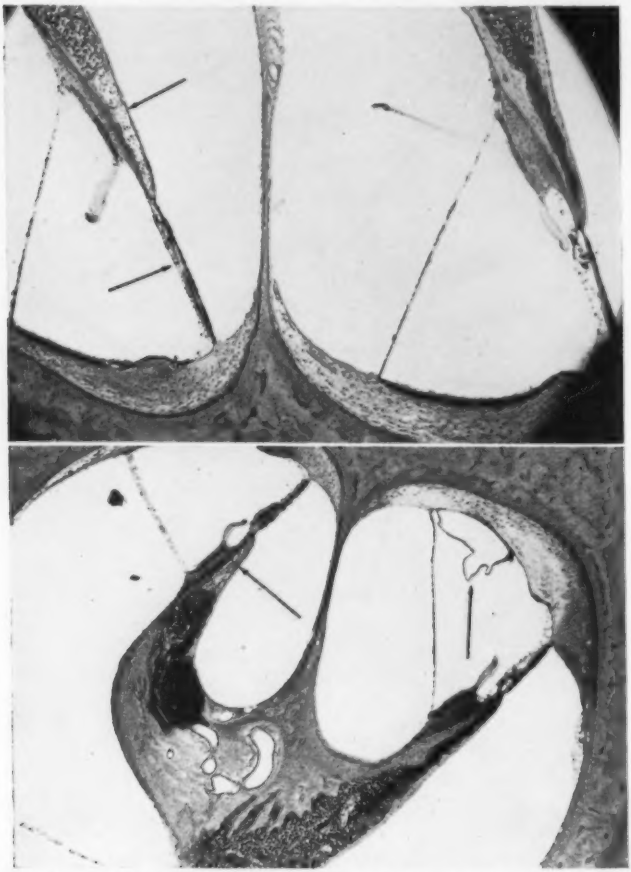

Fig. 7A. Rabbit 28. Left Ear. One month after exposure. Severe end-organ and nerve changes up to spiral ganglion — lower end of second coil. The acoustic reflex was obliterated (see Table XIX).

Fig. 7B. Rabbit 28. Left ear. One month after exposure. Atrophy of stria with cyst formation, basal turn, end-organ and nerve degeneration, lower end of second turn. Stria opposite this area (not shown) appears normal. Acoustic reflex obliterated (see Table XIX).

that of the middle ear muscles (see Ruedi and Furrer) and thus offers a smaller auditory area for exploration of function. Ruedi and Furrer also observed that the pinna reflex was abol-

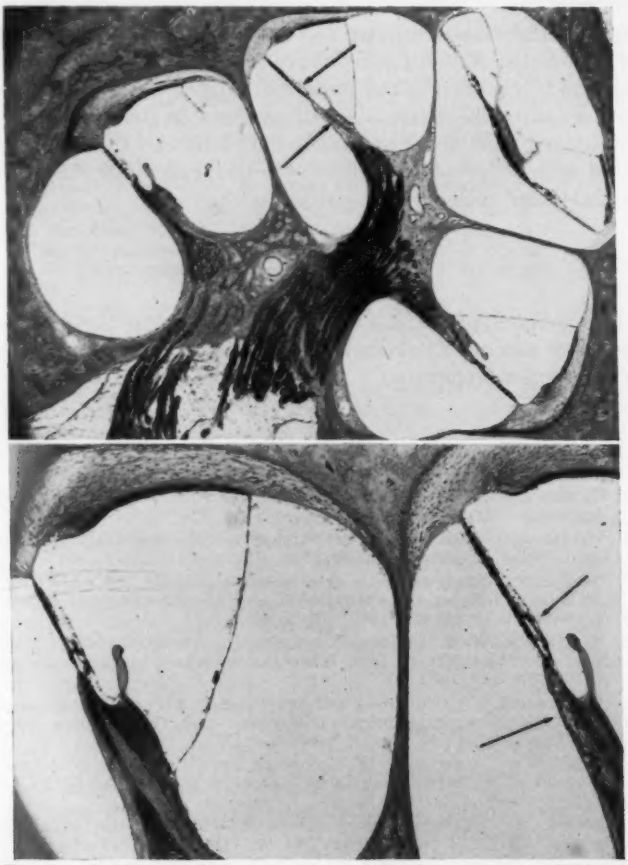

Fig. 8A. Rabbit 25. Left ear. One month after exposure. Widespread end-organ and nerve degeneration up to the spiral ganglion through the middle of the cochlear duct. The reflex response was reduced throughout the frequency range explored in the ear. The reflex response of the opposite ear was obliterated (see Table XVI).

Fig. 8B. Rabbit 29. Right ear. One month after exposure. End-organ and nerve fibres upper end of second turn pathological. Acoustic reflex was only slightly affected. Note the good end-organ and dense nerve bundle of Rosenthal's canal in the coil below (see Table XX).

ished when only a limited area of the cochlea was injured; however, they also observed that some damage was compatible with a good pinna reflex — so that they, too, did not find a good correlation between the complete or partial loss of auditory function due to gunfire as tested by the pinna reflex and the associated histological picture in the cochlea. Much remains to be clarified in our understanding of the way in which the cochlea works, especially with regard to the difference in sensitivity of the outer and inner hair cells and the area stimulated with different intensities of sound, especially with large asymmetrical pulses like the shock wave.

CONCLUSION.

Severe functional and histological damage to the auditory apparatus can result from shock pulses that do not damage the conduction apparatus.

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INTERNATIONAL CONGRESS OF OTOLARYNGOLOGY, LONDON, 1949.

The British Association of Otolaryngologists is organizing the Fourth International Congress of Otolaryngology, to be held in London from July 17 to July 23, 1949. There will be further meetings, for those who wish to go, at Oxford, Cambridge and Edinburgh on July 25 and 26. It is hoped that a full academic program will be arranged, and also various social functions.

The secretaries of the National Otolaryngological Societies have been circularized and asked to send a list of their members for individual notification. Should any association not receive this letter, they should communicate with the General Secretary, F. C. W. Capps, F.R.C.S., 45, Lincoln's Inn Fields, London, W.C. 2.

TONSILLECTOMY-POLIOMYELITIS SURVEY — 1947.*†

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At the annual meetings of this Society last year and the year before, I discussed somewhat in detail the exhaustive experimental work that has been done on the etiology, epidemiology, mode of transmission and portal of entry of the virus of poliomyelitis. During the past year nothing new has been added to our knowledge along these lines, and I will not take up your time today in reviewing this work; but simply set forth before you what we have accomplished on the tonsillectomy survey as carried out by the different members for the year 1947.

This survey, to be of any real value, must be absolutely accurate; consequently, many state reports had to be discarded again this year for one reason or another. Some failed to report which type of poliomyelitis the patient had, others omitted to state whether or not an operation was performed, and many sent in letters giving their own interpretations, rather than following the questionnaires, thereby omitting very necessary information. Others sent in no report at all.

Your committee has spent a great deal of time trying to make this work easier for the different state chairmen and decided that by filling out the questionnaires, that contain only five questions, gave us all the necessary information with the least amount of work.

Although several hundred questionnaires had to be discarded for the lack of sufficient information, we have done much better this year than last. We have tabulated reliable information from 25 states, compared with 13 states a year

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ago, and have traced 43 per cent of the poliomyelitis cases reported throughout the country in 1947, compared with 23 per cent for 1946. The disease was rather mild in 1947 and only about half of the number of cases were reported compared to 1946. In only three or four states did it reach epidemic proportions; namely, Ohio, Delaware, Idaho and North Carolina. Table VI will show that the mortality rate was much lower in 1947. There are certain years that the virulence of the virus is much less than others.

Table I shows the cases of poliomyelitis by age groups and, like the 1946 survey, shows the greatest number of cases of each type of poliomyelitis occurred in the six to 10-year group, with the exception of the spinal type.

Table II shows the distribution of cases by states, the type of involvement and operative procedures.

Table III, which shows the types of poliomyelitis, with the number and per cent preceded by tonsillectomy and the number and per cent preceded by other operations, shows a complete reversal of form for the same table in 1946. The 1946 survey showed that 2.5 per cent of all cases followed were preceded by tonsillectomy, while the 1947 survey shows only 0.5 per cent. The 1946 survey showed that only 1.1 per cent of the poliomyelitis cases were preceded by other operations, whereas the 1947 survey shows 1.9 per cent of the cases were preceded by other operations — or about four times as many as were preceded by tonsillectomy. The same thing holds true for the bulbar, spinal and mild types, as you will see from the slides. Why this wide discrepancy of figures? There were a large number of cases of poliomyelitis this year, not as large, I'll grant, as in 1946, but, nevertheless, there were over 10,000 cases, which has been exceeded only eight times in the history of the disease in this country. In the four states mentioned above, it reached epidemic proportions. These figures are accurate, as we followed each case reported here. I believe that the main reason for this discrepancy is that we understood much better this year than we did last year how to go about obtaining the necessary data and to tabulate it properly.

TABLE I.
CASES OF POLIOMYELITIS BY AGE—TYPE OF DISEASE—OPERATIVE PROCEDURES.

Age	Total Cases	Total Operations	T & A Other	Type of Disease: Bulbar Total Operations	Bulbar T & A Other	Spinal Total Operations	Spinal T & A Other	Mild Total Operations	Mild T & A Other
Total	4,331	24	81	509	6	16	2,230	10	45	1,592	8	20
0- 5	1,167	4	25	91	1	2	656	1	16	420	2	6
6-10	1,236	15	18	152	3	3	597	7	10	487	5	5
11-16	914	3	10	123	2	1	413	1	4	378	0	5
17 and over	1,014	2	28	143	0	9	564	1	15	307	1	4

TABLE II.
TYPE OF DISEASE—OPERATIVE PROCEDURES AND CASES OF POLIOMYELITIS BY STATE.

State	Total Cases			Bulbar			Spinal			Mild			Cases Reported by U. S. Public Health
	Total	Operations		Total	Operations		Total	Operations		Total	Operations		
		T & A	Other		T & A	Other		T & A	Other		T & A	Other	
Total	4,331	24	81	509	6	16	2,230	10	45	1,592	8	20	6,462
Ohio	853	5	28	124	1	9	299	2	12	430	2	7	1,467
New York State	760	5	21	69	2	2	369	1	14	322	2	5	890
New York City	220	2	3	30	0	0	9	0	0	181	2	3	354
Illinois	721	2	3	47	0	1	456	2	2	218	0	0	860
New Jersey	285	1	1	33	0	1	148	1	0	104	0	0	298
North Carolina	230	1	7	30	1	0	123	0	6	77	0	1	303
Massachusetts	190	1	6	31	0	1	77	0	2	82	1	3	357
Indiana	150	0	0	3	0	0	147	0	0	0	0	0	260
Rhode Island	140	3	2	27	2	2	106	1	0	7	0	0	142
Nebraska	130	2	3	19	0	0	82	1	3	29	1	0	206
Idaho	121	0	1	25	0	0	96	0	1	0	0	0	353
Oregon	98	0	0	20	0	0	55	0	0	23	0	0	110
Arkansas	60	0	0	1	0	0	56	0	0	3	0	0	83
Kansas	59	1	0	12	0	0	32	1	0	15	0	0	99
Tennessee	42	0	1	4	0	0	24	0	1	14	0	0	176
Oklahoma	40	1	2	2	0	0	26	1	1	12	0	1	58
Vermont	39	0	1	5	0	0	26	0	1	8	0	0	41
Maine	36	0	2	5	0	0	26	0	2	5	0	0	46
South Dakota	32	0	0	3	0	0	19	0	0	10	0	0	36
North Dakota	31	0	0	2	0	0	15	0	0	14	0	0	70
New Hampshire	28	0	0	3	0	0	14	0	0	11	0	0	30
Alabama	28	0	0	1	0	0	8	0	0	19	0	0	51
New Mexico	24	0	0	8	0	0	11	0	0	5	0	0	40
Missouri	14	0	0	5	0	0	6	0	0	3	0	0	132

I apologize to Dr. Edley Jones, Chairman of the State of Mississippi, for not having his state tabulated with the others. Through an error in our office, the report of the state of Mississippi was unintentionally omitted. By the time our mistake was discovered it was too late to incorporate his findings in the charts. Dr. Jones reported that there were 46 cases followed out of a 63 total. There were five bulbar, three spinal and 18 mild. There were two deaths and they were in the bulbar group. None of these cases were preceded by operation.

TABLE III.
1947.

Type	Cases Preceded by T & A			Cases Preceded by Other	
	Tot. Cases	No.	%	No.	%
Total	4,331	24	0.55	81	1.9
Bulbar	509	6	1.2	16	3.2
Spinal	2,230	10	0.5	45	2.0
Mild	1,592	8	0.5	20	1.3
1946					
Total	2,476	62	2.5	27	1.1
Bulbar	382	18	4.7	9	2.4
Bulbar Sp.	62	5	8.0	0	0.0
Spinal	1,292	24	1.9	11	0.8
Mild	616	14	2.3	6	1.0
Unknown	124	1	0.8	1	0.8

TABLE IV.
Distribution by Age Groups: Number and Percentage of Cases of Poliomyelitis Preceded by Tonsillectomies and by Other Operations.

Age	Cases Preceded by T & A			Cases Preceded by Other Operations	
	Tot. Cases	No.	%	No.	%
0- 5	1,167	4	0.3	25	2.2
6-10	1,236	15	1.2	18	1.5
11-16	914	3	0.3	10	1.1
17 and over	1,014	2	0.2	28	2.7
Total	4,331	24	0.5	81	1.9

Reports for the following states were received a few days ago and, unfortunately, could not be incorporated in the slides and paper, due to their late arrival:

State of Connecticut: Cases, 130; bulbar, 16; spinal, 26; mild, 89. Of the above, there were six deaths in the bulbar group. From a total of 130 cases, seven had operations within the two-month period prior to the onset of poliomyelitis; five

of these had their tonsils and adenoids removed; two, tooth extractions. All of these cases were of the mild type of poliomyelitis and made complete recoveries. None were of the bulbar type.

State of Colorado: Cases, 63; bulbar, nine; spinal, 47; mild, seven. Of the above, there were six deaths; two spinal, three bulbar, one no type. From a total of 63 cases, four had opera-

TABLE V.
Distribution by States: Number and Percentage of Cases of Poliomyelitis Preceded by Tonsillectomies in Each State.

		1947 Cases Preceded by T & A		1946 Cases Preceded by T & A		
State	Tot. Cases	No.	%		No.	%
Total	4,331	24	0.5	2,476	62	2.5
Ohio	853	5	0.6	316	9	2.8
New York State	760	5	0.7	135	1	0.7
New York City	220	2	0.9	596	21	3.5
Illinois	721	2	0.3	257	5	1.9
New Jersey	285	1	0.4	229	4	1.7
North Carolina	230	1	0.4			
Massachusetts	190	1	0.5	306	7	2.3
Indiana	150	0	0.0			
Rhode Island	140	3	2.1			
Nebraska	130	2	1.5			
Idaho	121	0	0.0	22	0	0.0
Oregon	98	0	0.0	78	3	3.8
Arkansas	60	0	0.0	312	5	1.6
Kansas	59	1	1.7			
Tennessee	42	0	0.0			
Oklahoma	40	1	2.5			
Vermont	39	0	0.0			
Maine	36	0	0.0			
South Dakota	32	0	0.0	15	0	0.0
North Dakota	31	0	0.0			
New Hampshire	28	0	0.0	141	5	3.5
Alabama	28	0	0.0			
New Mexico	24	0	0.0			
Missouri	14	0	0.0			

tions within the two-month period prior to the onset of poliomyelitis; one appendectomy, one fracture of arm, one full term delivery, one tooth repair. All of these cases were of the spinal type.

State of Maryland: Cases, 91; bulbar, 19; spinal, 58; mild, 14. Of the above, there were six deaths; all of the bulbar type. From a total of 91 cases, seven had operations within the

TABLE VI. DEATHS FROM POLIOMYELITIS.

Age Group	Cases of Polio-myelitis	Number in Which Death Resulted	Case Fatality Rate
1947.			
0- 5	1,167	17	1.5
6-10	1,236	17	1.5
11-16	914	20	2.2
17 and over	1,014	40	4.0
Total	4,331	94	2.2
1946.			
0- 5	658	23	3.5
6-10	807	27	3.3
11-16	711	40	5.6
17 and over	300	30	10.0
Total	2,476	120	4.8

TABLE VII. BULBAR TYPE OF POLIOMYELITIS.

1947.		
Total number of cases of poliomyelitis	4,331	
Total number of cases of bulbar type	509	or 11.6%
Bulbar cases following tonsillectomy	6	or 1.2%
Bulbar cases following other operations	16	or 3.2%
Bulbar cases following no operations	487	or 95.6%
1946.		
Total number of cases of poliomyelitis	2,476	
Total number of cases of bulbar type	382	or 15.4%
Bulbar cases following tonsillectomy	18	or 4.7%
Bulbar cases following other operations	9	or 2.4%
Bulbar cases following no operations	355	or 92.9%

TABLE VIII. TONSILLECTOMIES.

		Contracted Poliomyelitis	Type of Poliomyelitis
1947			
New York	2,437	1	Spinal
Ohio	54		
Pennsylvania	564		
Massachusetts	85	1	Mild
Illinois	80		
Tennessee	262		
South Carolina	250		
Texas	213		
Louisiana	240		
New Jersey	10		
Indiana	60		
Maine	310		
Nebraska	61		
Missouri	48		
Rhode Island	275		
Total	5,439		

two-month period prior to the onset of poliomyelitis; one appendectomy, five tooth extractions, one tonsillectomy and adenoidectomy. Of these cases, five were of the spinal type, two of the bulbar group — one of which was a tonsillectomy and adenoidectomy.

District of Columbia: Cases, 21; bulbar, three; spinal, 12; mild, six. Of the above, there were no deaths. From a total of 21 cases, there were no recorded operations within the two-month period prior to the onset of poliomyelitis.

State of Wyoming: Cases, eight; bulbar, two; spinal, five; mild, one. Of the above, there was one bulbar death. From a total of eght cases, there were no recorded operations within the two-month period prior to the onset of poliomyelitis.

State of Utah: Cases, 22; bulbar, six; spinal, 16; mild, none. Of the above, there was one bulbar death. From a total of 22 cases, there were no recorded operations within the two-month period prior to the onset of poliomyelitis.

Much interesting information was gained by reading over many of the returned questionnaires. It was surprising this year to find so few that connected swimming with the onset of the disease. Other years a large percentage seemed to connect swimming in one way or another with the onset of poliomyelitis. It has been known for a long time that sudden chilling of the body surfaces often predisposed to an attack of poliomyelitis. This year, *i.e.*, 1947, for the first time it was noticed that a great many pregnant women deveoped the disease, most of them in the late months of pregnancy or shortly after the birth of the child. Also, a great number of cases followed shortly after the children were given injections for diphtheria, whooping cough, tetanus and rabies.

Several parents told of the little patients playing in an old watery mud hole near a riding stable a week or two before contracting poliomyelitis. In a small town in Ohio, where the epidemic reached high proportions, the water supply was condemned by the board of health as the probable cause of the epidemic. Another mother reports that a few weeks before her boy was stricken with spinal-poliomyelitis, there was a

hard rain that flooded the street and the boy waded in the water. Two days later he developed an infected leg which was difficult to heal, and contracted poliomyelitis two weeks later. There were six other cases reported in her immediate neighborhood following that rain storm. In New York City, many of the cases occurred in the poorer tenement districts where the hygienic surroundings were bad. Vermin of all sorts, flies, mosquitoes, roaches, rats, etc. In the past, many investigators have incriminated flies in the transmission of the virus. In the town of Caldwell, Ida., during the past summer a successful war on flies was waged by local and state health authorities, using DDT to wipe out common house flies and many other species that assumed pest proportions. In this apparently fly-free community, outbreaks of poliomyelitis continued, deaths resulted and the town and state reached epidemic proportions. The virus of poliomyelitis may thrive in filth and dirt. One child, age five, living in Massachusetts, had a tonsillectomy in July; three days later his father came down with spinal-poliomyelitis. Another child in Massachusetts had a tonsillectomy and his sister, seven years old, developed poliomyelitis one week later. A child in White Plains, N. Y., had a tonsillectomy in August and five days later his mother developed poliomyelitis. None of the three children who had the tonsillectomies performed contracted the disease.

You will note on the slides that the words "other operations" are often mentioned. These operations consist of the following: tooth extractions, excision of facial scar, laceration above eye, excision of cyst of foot, episiotomy, hydrocele operation, tracheotomy, hysterectomy, circumcision, hemorrhoidectomy, fissure in ano, thyroidectomy, puncture of foot with rusty nail, vaccinations, many appendectomies, and injections of diphtheria antitoxin, tetanus and whooping cough sera. Many gave histories of their attack following dog bites, bee stings, broken bones and the exanthemata, but these were not included in "other operations."

In addition to following the poliomyelitis cases, we also investigated 5,439 tonsillectomy cases performed in 15 different states during the year 1947. All of these cases were

checked for two months after their operations to see if they developed any illness, especially poliomyelitis, within the two-month period. Out of this total number, two cases contracted poliomyelitis. One, a seven-year-old girl, of Salem, Mass., had a tonsillectomy on July 22, 1947. On Aug. 11, she was re-admitted to the hospital with a mild poliomyelitis and was discharge two weeks later, apparently recovered. The other was a seven-year-old boy who had a tonsillectomy at the Manhattan Eye, Ear and Throat Hospital on Oct. 3, 1947. He was admitted to the contagion hospital on Oct. 26, 1947, with spinal poliomyelitis. He made an uneventful recovery. Out of theses 5,439 tonsillectomies performed in 15 states, which represent a good cross-section of the country, not one of these cases contracted bulbar poliomyelitis and only one spinal and one mild followed. An incidence of less than one-twentieth of 1 per cent.

At the meeting of this Society in Chicago two years ago, I reported 11,204 tonsillectomies performed at the Manhattan Eye, Ear and Throat Hospital, New York City, over a seven-year period. But four of these cases contracted poliomyelitis within the two-month period, and none were of the bulbar type.

CONCLUSIONS.

After several years' work on this poliomyelitis-tonsillectomy survey, and watching the analysis and classification of thousands of cases into bulbar, spinal and mild, into the different age groups, the number of poliomyelitis cases following tonsillectomies and those following other operations and injuries, from all sections of the country in mild years and severe ones, I am more convinced than ever that there is no causal relationship between the two, and that when a bulbar poliomyelitis follows a tonsillectomy it is coincidental.

I do not advocate the indiscriminate removal of tonsils during any severe epidemic, and have no desire to place our patients' lives in jeopardy through injudicious surgery, but I certainly do not think that this operation should be postponed

indefinitely simply because the summer months are the months that poliomyelitis is prevalent.

I would like to see this survey carried on from year to year, for I feel certain that when we have accurate statistics on thousands and thousands of these cases, it will be difficult to convince anyone that tonsillectomy predisposes a patient to poliomyelitis.

I also believe that this work of gathering and compiling these statistics should be taken off the doctors' hands. It is a laborious job, and they really do not have the time to devote to it.

I believe if we had a central office with several girls, we could do this work without annoying the doctors. These girls, who would devote all their time to this job, could follow and tabulate these cases every month, act as field epidemiologists, thus enabling them to personally contact the parents, study the home environment and thereby obtain more complete and accurate information in the epidemic states. I also believe that the expense of this, which would not be very much, should be paid by the National Foundation. They are spending millions each year fighting infantile paralysis and this work is certainly part of their job.

In conclusion, I thank the various state chairmen who did real fine jobs this year and made this survey possible. I also thank the 50-odd doctors who were kind enough to follow their tonsillectomy cases for two months and forwarded their reports to me.

HEMOPHILUS INFLUENZAE TYPE B EPIGLOTTITIS OR ACUTE SUPRAGLOTTIC LARYNGITIS IN CHILDREN.*

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Acute obstructive laryngitis in children is usually considered to be caused by diphtheria or to be a disease of nonspecific bacterial origin, acute laryngotracheobronchitis. Recently, however, another specific organism, the hemophilus influenzae type B, has been described as causing a newly recognized obstructive inflammatory lesion of the larynx.

In 1941, Sinclair[11] reported 10 patients with an acute obstructive laryngitis in which hemophilus influenzae type B was found by blood cultures. In all of these instances, their clinical picture was characterized by *1.* an abrupt onset and short fulminating course, *2.* great swelling and injection of the epiglottis and other supraglottic structures, *3.* fever and leucocytosis, and *4.* prostration and shock.

The same consistent picture of sudden onset, of pain in the throat, rapidly increasing dyspnea and early prostration, coupled with the finding in each patient of an acute epiglottitis and the establishment of H. influenzae type B organism as the etiologic agent, was reported by Alexander,[2] in 1942, in 10 cases.

Previously, Le Mierre,[9] in 1936, had associated this organism with a patient presenting a similar picture. Holt,[7] in his textbook published in 1940, stated that the H. influenzae type B caused infections in children and infants and had never been isolated from children except under circumstances in which it appeared to be playing a pathogenic rôle. He noted that cases had been seen with severe inflammatory reaction

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in the epiglottis that obliged the patient to protrude the tongue in order to widen the airway for each inspiration.

In 1942, De Navasquez[4] reported the first patient in Great Britain who presented the clinical picture described by Sinclair,[11] and who had a septicemia due to H. influenzae type B.

Later, in the United States, Du Bois[5] and Aldrich reported four such patients in 1943; Stiegler[12] reported one in 1946, and Davis[3] reported three in 1947.

In their most recent textbook published in 1947, Jackson and Jackson list the H. influenzae type B as one cause of laryngotracheobronchitis, but do not specify a supraglottic lesion.

The disease first appeared in the records of Children's Hospital of Los Angeles in 1944, during which year three patients were diagnosed as having an acute epiglottitis due to H. influenzae type B.

During 1945, three more patients were so identified, and by this time all cases of acute obstructive laryngitis in children, usually admitted with the diagnosis of "laryngotracheitis" or "laryngotracheobronchitis," were being examined clinically and bacteriologically to determine the presence of the H. influenzae type B as the etiologic agent.

The purpose of this thesis is to present the clinical and laboratory findings in such patients during a one-year period, that is, 1946, in order to determine the following:

1. Does the H. influenzae type B cause a consistent clinical picture in children that can be differentiated from that seen in most cases diagnosed as "laryngotracheobronchitis"?

2. Is the H. influenzae type B organism found in patients with typical subglottic laryngotracheitis?

3. What is the importance of the establishment of this organism as the exciting cause in regards to treatment and prognosis?

4. If this is a newly recognized clinical entity, what are its distinguishing features in diagnosis?

MATERIAL AND PROCEDURES.

From Jan. 1 to Dec. 31, 1946, there were 5,220 admissions to the Los Angeles Children's Hospital, an institution with 203 beds for children only. During this year, 49 patients were admitted with an acute obstructive laryngitis. The discharge diagnoses revealed two of these to have been diphtheria; 39 were diagnosed as laryngotracheobronchitis, and eight patients had H. influenzae type B epiglottitis, or supraglottic laryngitis. It is at once seen that this last disease is not rare and must be considered in a differential diagnosis of acute obstructive laryngitis in children.

Routine examination to make this differentiation consisted of obtaining first an adequate history as to onset, course, and with special emphasis on initial complaints as sore throat, painful or difficult swallowing, hoarseness and difficult breathing. The usual complete general physical examination was done, noting especially color; stridor; retractions, suprasternal, xiphoid and intracostal; degree of restlessness or fatigue; pulse rate and character. Ear, nose and throat examination always included inspection of the epiglottis. This was possible in every case by depression of the tongue with ordinary tongue depressors. The larynx was examined in all severe cases, which included the eight with epiglottitis, by indirect mirror examination or direct laryngoscopy performed either at the time of tracheotomy or as an independent examination.

Material for smear and culture was obtained from the nasopharynx and the epiglottis, when it was found to be swollen, by swabbing the mucosa of these areas. Routine laboratory examination included an immediate attempt to identify and type the H. influenzae by "Quelling," that is, by demonstrating capsular swelling with type-specific serum using the technique of Alexander,[1] Craig, Shirley and Ellis:

One drop of methylene blue is added to one drop of an infusion from the swab or to material smeared on a slide by the swab. Then one loopful of H. influenzae type B rabbit antiserum is added and a cover slip placed over the slide. The preparation is observed immediately and after 30 minutes for

an enlarged capsule about a small, short bacillus or coccobacillus. The organisms stain blue and sometimes are slender.

Routinely a smear was made and stained with Gram stain, and observed for Gram positive and negative organisms and for pus cells. The H. influenzae is Gram negative. Another smear is stained with toluidine blue for the Klebs-Loeffler bacillus, and a culture made on Klebs-Loeffler media.

Cultures were streaked on a blood agar plate and upon a chocolate agar plate, and then the swab was dropped into blood broth. "Quelling" of colonies that appeared was then done. The chocolate agar plates yielded the greatest amount of growth.

A complete blood count and urinalysis was also done.

RESULTS.

Age: Five patients with epiglottitis were two years old. One, the youngest, was 18 months of age, and two were four years old. While this average group of two years is about the same as that in the laryngotracheobronchitis group, there were many more patients less than two years old in the latter.

Incidence: Five cases occurred in the Fall (three in October), while the other three were scattered over the first half of the year (February, April and July). In this hospital, admissions for laryngotracheobronchitis are fairly equal throughout late Fall, Winter and early Spring.

History: The onset of symptoms was much more abrupt and unexpected in the eight patients with epiglottitis. In five cases the patient had gone to sleep in the evening in seemingly normal health, only to awaken in from three to five hours with a sore throat, fever and difficulty in breathing. One of these patients had convulsions within five hours after going to bed well. In the other three patients, the longest history obtained of complaints prior to admission was 10 hours. In the cases of laryngotracheobronchitis, the onset was insidious and on the average there was a history of two days' illness before admission. The course was much more rapid and ful-

minating in the patients with the H. influenzae infection. In two cases, great dyspnea, pale cyanosis and "shock" were evidenced on admission five hours after the onset of symptoms and immediate tracheotomies were necessary. In one patient, this picture was presented after eight hours, and a fourth patient needed a tracheotomy at the end of 16 hours.

Complaints: Sore throat was constantly complained of by the patients with epiglottitis if they were old enough to do so. Three complained of inability to swallow, and two gagged upon attempting to drink water.

High fever, 104° to 106°, was noted on admission in five of the eight cases of epiglottitis, but the patients with laryngotracheitis averaged between 102° and 103°.

Hoarseness, usually severe, was a constant complaint in laryngotracheitis, but rarely noted in H. influenzae patients; rather, their voices were muffled, thick or gutteral.

Findings: The patients with H. influenzae epiglottitis uniformly exhibited more evidence of toxemia, prostration and exhaustion than those with laryngotracheitis. Three of the eight were in "shock" and gave evidence of early anoxia, the symptoms of which have been so aptly described and their importance stressed by Galloway.[6] Five patients had a pale or ashen color, while cyanosis, if present in the patients with laryngotracheitis, was of varying degrees of duskiness.

Stridor, both inspiratory and expiratory, was present in all cases of subglottic laryngitis but was inspiratory only in three of the epiglottitis patients, and a gasping or gulping for air in three others.

With the exception of restlessness in a few cases (three), the children with laryngotracheitis would lie quietly flat in bed, but three patients with epiglottitis insisted upon sitting up and forward to breathe easier, and one kept her arms hung up over the side of her crib to assist her respirations.

Much mucus was found in five of the eight cases of epiglottitis, and two of these drooled. This was not noted in the

laryngotracheitis patients. Injection of the pharynx was neither severe nor constant in either series of patients.

The epiglottis was fiery red and greatly swollen in all eight cases of H. influenzae type B infection. In two instances it was swollen eight to 10 times its normal size, and about six times its normal size in the others. In the patients classed as laryngotracheitis, the epiglottis was almost always normal. In a few instances it was slightly injected and swollen about twice its normal thickness. In four cases of epiglottitis, the aryepiglottic folds and arytenoids were swollen and inflamed. In two of these, there was extreme swelling of the false cords also, and these two patients exhibited the greatest amount of dyspnea. In the other four cases the epiglottis alone was involved. In only one of the eight cases did the true cords appear unusually inflamed. In none was there the swollen pads of subglottic tissue as was seen in laryngotracheitis. In none of the cases of laryngotracheitis was there moderate or severe supraglottic swelling.

Laboratory: White blood cell count revealed a leucocytosis in all patients with epiglottitis, ranging from 8,600 to 45,900, but the degree of leucocytosis had no relationship to the severity of the disease. One of the milder cases had the second highest count, 33,650, while the most sick patient had the second lowest count, 9,850; however, all cases had a high percentage of polymorphonuclear cells, ranging from 73 to 90 per cent.

Smears made on admission from material swabbed from the nasopharynx and epiglottis showed "Quelling" of organisms resembling the H. influenzae with H. influenzae type B antiserum in only four cases of the epiglottitis group, but after 12 hours, cultures yielded organisms that "Quelled" in all eight cases.

In no case of laryngotracheitis was "Quelling" demonstrated in either smears or cultures, although smears in three cases had organisms resembling the H. influenzae. These probably were of the nonpathogenic type A. From cultures, the alpha streptococcus, the beta streptococcus and the staphylococci

were each demonstrated in about one-third of the patients. The pneumococcus, type III, was cultured in one case.

Blood cultures were not done. Urinalysis findings were not distinctive.

TREATMENT.

The greatest evidence of the importance of the recognition of H. influenzae type B infections is found in a study of the results of treatment. The laryngotracheitis cases routinely received cool steaming, intramuscular penicillin and intravenous or intramuscular sulfadiazine, in addition to supportive measures. Tracheotomies (five) were done when indicated. There were two deaths in this series.

All eight cases of epiglottitis received intramuscular or intravenous sulfadiazine, and three received intramuscular penicillin; but the five most severely sick patients received H. influenzae type B rabbit antiserum upon demonstration of the fiery red, swollen epiglottis even though smears on admission failed to demonstrate "Quelling" in two of these cases. The initial dose was 50 mgm. in the milder cases or youngest patients, and 100 mgm. in the sicker or older children. The response to this therapy was prompt, usually within six to eight hours, and dramatic. Only one patient needed the dose repeated. This was done after 12 hours.

Although the epiglottitis patients, as a group, were much more ill and presented greater dyspnea, prostration, "shock" and toxic symptoms, there were no deaths in this group. The greater severity of their illness was further proved by the fact that four (or 50 per cent) required tracheotomies; three upon admission, and one after two hours.

Treatment with Streptomycin: It should be stated here that after noting the reports of excellent results in the use of streptomycin in treatment of meningitis caused by the H. influenzae type B, that the four patients which have been diagnosed so far during 1947 as having H. influenzae type B epiglottitis have received this drug. Two received streptomycin and sulfadiazine alone and two received in addition the

type-specific H. influenzae rabbit antiserum. Equally satisfactory results and recovery occurred in all four cases. According to weight, the dosage was 1 to 2 gm. per day given in divided doses every three hours for three days.

DISCUSSION.

The data given above surely indicates to me that the H. influenzae type B organism causes an acute obstructive laryngitis in small children. The early recognition and institution of special treatment of this disease will result in the saving of lives. Holt[7] stated that H. influenzae meningitis not treated with rabbit antiserum showed a mortality of 92 to 98 per cent.

Sinclair[11] suggests the use of the antiserum for patients not responding to tracheotomy and chemotherapy.

Alexander,[2] *et al.*, advised the use of antiserum in the severely ill patients and those who do not respond to chemotherapy in 24 hours.

The differentiation of this disease from so-called "laryngotracheobronchitis," under which term it has probably been included in the past, is important and necessary so that type-specific antiserum and/or streptomycin therapy can be given. One or both of these drugs are given to patients at the Children's Hospital as soon as the diagnosis is made by "Quelling," or is suspected because of an epiglottitis, unless the disease seems so mild clinically that sulfadiazine alone is safe to try for 12 hours.

The differentiation is made upon the finding of a greatly swollen and injected epiglottis and is confirmed by the demonstration of "Quelling" or capsular swelling of organisms obtained by smear or culture, with H. influenzae type B antiserum. The history of an abrupt onset with complaints of a severe sore throat or painful, difficult swallowing and a short, rapid, fulminating, 12 hours or less, course of increasing dyspnea, fever and toxic symptoms, will suggest this disease. The findings of pale cyanosis, severe prostration and "shock" will also indicate this infection.

The laryngeal obstruction is due to swelling of the epiglottis, sometimes in conjunction with other supraglottic structures, especially the false cords. The true cords and subglottic areas are not noticeably involved. In the nonspecific laryngotracheitis or tracheobronchitis, the obstruction is subglottic, but obstructive swelling of the supraglottic structure is not seen. Demonstration of the H. influenzae type B as the cause of this condition was not made in my series.

Upon an anatomical basis, the term "acute supraglottic laryngitis" is probably a better one than "acute epiglottitis" for this clinical entity caused by the H. influenzae type B; however, "acute epiglottitis" better accounts for its distinguishing symptoms and findings.

Bacteriology: The hemophilus influenzae or "Pfeiffer's" bacillus was first described by Pfeiffer, in 1892, and thought by him to be the etiological agent in epidemic influenza. Now it is believed to be a secondary invader in that disease but an important pathogen causing other lesions.

Pittman[10] showed that, of its many types, only a few show characteristics of a smooth phase. Only these smooth strains have been isolated from pathological sources and these can be divided into two well defined groups: type A and type B. Only these invasive smooth strains possess a capsule. The H. influenzae type B organism is a Gram negative, small, short bacillus or ovoid coccobacillus. It grows best on a chocolate agar media.

Holt[7] states that it has never been isolated from children, except under circumstances in which it appeared to be playing a pathogenic rôle.

Stillman[13] reports that the rough, or nonpathogenic, strains of H. influenzae may be recovered from the throats of normal adults, but the smooth strains were only recovered from patients suffering from acute infection of the respiratory tract.

Pathology: Inasmuch as all eight patients reported in this study recovered, it is necessary in discussing pathological

changes to refer to the postmortem examination of a seven-year-old child who died of this disease two years ago. In this patient the epiglottis was red and swollen to 4 cm. in thickness. Swelling of the aryepiglottic folds and arytenoids narrowed the glottic chink to 2 x 5 mm., but the swelling stopped at the ventricular bands, while the true cords and trachea were normal. Microscopically, some epithelium was absent. There was dense cellulitis. Tissues were almost obliterated by densely packed polymorphonuclears. Some small mononuclears and fibrin were present. Glands were about normal and blood vessels were packed with polymorphonuclears.

REPORT OF TYPICAL CASES.

Case 1: Mild Case: J. H., Case 5, a white girl, aged two years, was admitted to the Children's Hospital on Oct. 10, 1946, with the complaints of difficult breathing and restlessness. Ten hours before admission, there had been a sudden onset of a croupy cough and a muffled hoarseness, followed by a rapid increase in the cough, dyspnea and restlessness; she also had vomited and gagged.

Examination revealed an active child crying as if in pain. She was moderately hoarse, and her color was good. There were slight suprasternal and moderate substernal retractions. The pharynx was slightly injected, but there was abundant frothy, stringy mucus secretions in her mouth. The epiglottis was edematous, about four times its normal thickness, and deep red.

The nasopharyngeal smear was reported as negative and because of her mild symptoms she was given sulfadiazine intravenously and cool steam was instituted.

Her temperature fell from 104° to 100° in eight hours.

At the end of 12 hours the culture made from the mucosal swabbing yielded organisms that "Quelled" with H. influenzae type B antiserum, but by now she had no stridor or retractions.

The sulfadiazine was discontinued on the fourth day.

Case 2: Severe Case: M. F., Case 7, a white boy, aged 18 months, was admitted to the Children's Hospital on Nov. 8, 1946, because of great respiratory distress and collapse. He had gone to sleep, seemingly well, but awakened crying and vomiting at 7 P.M. A red throat and fever were noted at this time. At 12:15 the following morning, he had a convulsion and rapidly increasing respiratory distress.

Upon admission three hours later, he had an ashen pallor and was groggy and tired. There was evidence of great inspiratory distress and stridor. Retractions were very severe. A fiery red, greatly swollen epiglottis was easily seen upon depressing tongue and the pharynx was slightly red.

A smear taken from the epiglottis revealed organisms that "Quelled" with H. influenzae type B antiserum. W. B. C., 9,850; 74 per cent polymorphonuclears.

Direct laryngoscopy done for immediate tracheotomy over a bronchoscope revealed the epiglottis, arytenoids, aryepiglottic folds and false cords to be extremely swollen and injected. The glottic chink had to be forced open by the scope, but the true cords were found practically uninvolved.

Following the tracheotomy the patient was given 50 mgm. of the type-specific rabbit antiserum and sulfadiazine intravenously.

Rapid improvement followed. There was immediate relief of the dyspnea and its symptoms, and the child fell asleep. Within four hours, the temperature fell from 106° on admission to 101°. At the end of 12 hours, it was 100°. He was decannulized in five days and discharged two days later.

SUMMARY.

The clinical and laboratory findings in 49 patients admitted to the Children's Hospital, Los Angeles, with an acute obstructive laryngitis were reviewed. This study revealed that the eight cases diagnosed as H. influenzae type B epiglottitis presented findings that permitted them to be easily differentiated from patients with acute laryngotracheitis. The consistent, typical picture of this clinical entity, H. influenzae type B epiglottitis, was characterized by an abrupt onset in a well child of increasing respiratory distress. A sore throat, or painful and difficult swallowing, was usually an early complaint. The course was short, rapid and fulminating. Early severe prostration, pale cyanosis and "shock" were frequent findings. Respiratory distress was mostly inspiratory, a gasping or gulping for air. Inability to swallow, even sometimes their own saliva, was often noted. The diagnosis was practically made by simple tongue depression revealing the fiery red, greatly swollen epiglottis constantly seen in this disease. The demonstration of the H. influenzae type B by capsular swelling with type-specific antiserum confirmed the diagnosis. Treatment with early tracheotomy, type-specific rabbit antiserum (and later streptomycin) and sulfadiazine proved efficacious. A differential diagnosis of this disease and the other most common causes of acute obstructive laryngitis in children is given in Table 1.

CONCLUSIONS.

1. The H. influenzae type B does cause a consistent clinical picture in children that can be differentiated from that seen

TABLE 1.
DIFFERENTIAL DIAGNOSIS.

	Laryngeal Diphtheria	Laryngotracheitis	H. Influenzae Type B Epiglottitis
Onset and course	Insidious—2 to 4 days	1 to 2 days	Sudden. 6 to 12 hours
		SYMPTOMS.	
Hoarseness	+	+	0. Muffled
Fever	Low	High	High
Difficulty in swallowing	0	0	+
Dyspnea	Slow course	Faster	Fastest
		FINDINGS	
General appearance	Moderately ill, flushed	More ill, flushed, feverish	Extremely sick. Prostrated.
Stridor	Inspiratory and expiratory. Dry or wet	Inspiratory and expiratory. Dry. "Crowing"	Pale. Inspiratory mainly. Gulping and gasping. Tongue may protrude.
Oral examination	Membrane usually over tonsils and pharynx	Pharyngeal mucosa inflamed.	Pharynx slightly injected. Swollen, fiery red epiglottis
Laryngeal examination	Membrane or only inflammation	Glottis inflamed. Marked swelling of subglottic tissues.	Swelling usually limited to epiglottis
Smear and culture	K.L. bacillus	Strep. most frequent	H. influenzae type B by "Quelling"
		TREATMENT.	
Diphtheria antitoxin	+	0	0
Sulfadiazine	+	+	+
Penicillin	+	+	0
H. influenzae type B antiserum	0	0	+
Tracheotomy over bronchoscope	Early	Early	Earlier
Cool moisture	+	+	+
Streptomycin	0	0?	+

in most cases of acute obstructive laryngitis classed as laryngotracheobronchitis.

2. The H. influenzae type B is always pathogenic, but is not found in patients with typical subglottic laryngotracheitis.

3. The identification of the H. influenzae type B is of greatest importance in that early institution of therapy with type-specific rabbit antiserum and/or streptomycin, an addition to the previously accepted treatment of these cases of obstructive laryngitis, will save lives.

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IRRADIATION OF THE ADULT NASOPHARYNX: A STUDY OF ITS INFLUENCE ON OTOLOGICAL SYMPTOMS.*

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Since Crowe and Baylor[1] announced the splendid work of the Otological Research Laboratory of The Johns Hopkins Clinic on the prevention and treatment of deafness, the otological world has been greatly interested in the results attained by irradiation of the nasopharynx. Further and fruitful investigations have been made in this field, particularly by the original group;[2] but other able otologists[3] have also made valuable contributions.

With the exception of the excellent work on aerotitis[4] in the Service, these reports have dealt primarily with the results attained in treating children. It was inevitable that this method of treatment would be offered, and administered, to adults; and the author began investigating this field in January, 1941.

At first these treatments were given primarily with the idea of relieving blocked Eustachian canals and preventing further hearing loss, and little was promised the patient. For this reason, very few patients were interested. Later, with increased experience, it was felt more could be promised; and the number of patients and treatments increased rapidly. With an increasing number of patients undergoing treatment, it was found that not only further hearing loss was usually avoided but that other desirable results were being obtained. At first no adult patient was led to expect any improvement in hearing, but it was noted with surprise that in some cases there was an actual and demonstrable improvement. Even greater surprise was experienced when some patients volun-

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tarily reported improvement in tinnitus, and a few reported complete relief from that most annoying symptom. Logically, it had been thought that irradiation would afford some relief from the sensation of pressure in the ears; and it was not unexpected when many patients reported improvement, but it was gratifying. Another unexpected, but desirable, result was that many patients voluntarily reported fewer colds.

With so many reports of improvement received, it was thought that a survey of the patients' opinions of this method of treatment was justified. A review of the author's records revealed that 136 adult patients were given 331 irradiation treatments of the nasopharynx during the period of January, 1941, through June, 1947.

All of these cases had complete otolaryngological study, including nasopharyngoscopic examination, audiograms, tuning fork tests, and inflation of the Eustachian canals before and after irradiation treatment. Massage of the tympanic membranes with a Siegle or Yankhauer otoscope was also employed if there were any indications of adhesions in the middle ear or ankylosis of the ossicular chain. Irradiation therapy was advised only in selected cases.

The method of application followed the Johns Hopkins' technique, with one addition. Fisher[5] has emphasized the importance of applying the radium directly over, and in contact with, the orifice of the Eustachian canal. The author agrees with him, particularly as Burnam[6] stated that 75 per cent of the beta rays are absorbed in the first 3 mm. of tissue. Fowler[3c] obtained this result by using two radium applicators and slipping a short section of rubber tubing over the handles, holding them fairly firmly in place. The author uses only one applicator and attains the desired result by applying a strip of one-half inch adhesive tape to the bridge of the nose, looping it around the handle of the applicator and reattaching it to the nose in such manner as to hold the radium in the desired position (see Fig. 1). The position can be checked by passing a nasopharyngoscope through the other naris. Applying the radium properly is an important detail, and failure

to do so may be the difference between successful and unsuccessful results.

In order to study these cases and evaluate the results obtained, a questionnaire (see Appendix A) was devised to cover these fields of investigation:

Influence of irradiation on:

1. Hearing.
2. Tinnitus.
3. Sensation of pressure in the ears.
4. Frequency of colds.

In preparing any questionnaire, some definite psychological influence can be wielded by the wording of the questions. To obtain unbiased opinions, an attempt was made to make this questionnaire as neutral as possible. This was particularly important as two of these fields deal with purely subjective symptoms; and it is readily realized that few patients have any accurate idea of the degree of their hearing loss, and some have very little idea of the frequency of their colds.

A total of 62 more or less complete replies were received, representing 193 treatments. These were carefully checked with their office records; and their hearing losses,* before and after irradiation treatment, were calculated.

Necessarily these patients must be separated into two groups because of the difference in treatment. When Crowe[1] and his co-workers first announced their work, they were using radon, filtered with 1 mm. brass, applying from 2 to 2.5 gram-minutes' irradiation over each Eustachian canal orifice. This applicator principally utilized gamma rays. Later, for Army use in treating aerotitis, the monel metal radium applicator[6,4b] was devised, which principally utilized the hard beta rays.

Following the announcement of their investigations, the author personally visited The Johns Hopkins Otological Clinic to observe their work. At that time, radon and radium applicators were available for hospital and clinic use only. There seemed no reason why this procedure should not be utilized in office practice. At the author's request, The Radium Emanation Corporation made up a radon applicator in September, 1940, presumably the first applicator to be used for office treatment.[7] Six of the patients included in this study were given a total of seven treatments with this radon applicator. The remainder were treated with the monel metal radium applicator, the treatment period varying from applying 50 mg. over each Eustachian canal orifice for 6 minutes, 40 seconds (19,800 mg. sec.) as originally advised,[4b] to 8.5 minutes

*It is realized that there is no generally accepted standard of measuring clinical hearing loss, but it was thought that the Maico calculator standard would be adequate for this study.

(25,000 mg. sec.) as later advised.[6] Recently, after comparing radon and radium for this work, the treatment period has been increased to 50 mg. radium in each side for 12 minutes (36,000 mg. sec.).[8]

The replies to the questionnaire and calculations of hearing loss have been tabulated and are presented in Chart I.

DISCUSSION.

The group treated with the radon applicator is too small to justify any conclusion. Perhaps the fairest summary would be to say that sufficient improvement was noted to justify further studies of irradiation of the adult nasopharynx.

A study of the 56 cases treated with the monel metal radium applicator revealed some interesting statistics, and the remainder of this report is concerned with these cases.

HEARING.

It has been the experience of otologists that the majority of middle-aged patients who complain of impairment of hearing get progressively worse; and that the older the patient and the longer the duration of the impairment, the less likelihood of improvement and the greater the probability of further hearing loss. The elder Fowler summed up the situation nicely when he wrote, "Sometimes the best we can do is to help our patients lose their hearing slowly." It was with the hope that further hearing loss could be prevented that irradiation of the adult nasopharynx was first advised by the author.

Chart II is a compilation of the audiometric studies with breakdowns for sex, decades and duration; and these statistics are a challenge to some of our accepted ideas. The 56 patients had an average hearing loss of 17.2 per cent before treatment and an average hearing loss of 13.1 per cent after treatment, as estimated by the Maico calculator. That indicates an average of 4.1 per cent better hearing (not 4.1 per cent improvement—the average improvement was 23.8 per cent!). This

CASE HISTORY							PATIENTS' OPINION																								ACTUAL LOSS OF HEARING		
							IMPAIRMENT OF HEARING						TINNITUS							SENSATION OF PRESSURE									FREQUENCY OF COLDS				
	IDENTITY	SEX	AGE	NUMBER OF APPLICATIONS	MONTHS SINCE TREATMENTS	DURATION (YEARS)	% LOSS	IMPROVED	NO CHANGE	WORSE	% CHANGE	TINNITUS	DURATION (YEARS)	MILD	MODERATE	SEVERE	IMPROVED	NO CHANGE	WORSE	% CHANGE	PRESSURE	DURATION (YEARS)	MILD	MODERATE	SEVERE	IMPROVED	NO CHANGE	WORSE	% CHANGE	FEWER	SAME	MORE	BEFORE TREATMENT	AFTER TREATMENT	%ESTIMATED WITH MAICO CALCULATION
RADON APPLICATOR																																	
1	M.B.	m	29	1	76	2	50		✓		–	✓	2			?	✓		–	✓	2		✓			✓	–	✓			2.6	1.3		Thinks Adenoidectomy Helped - No benefit from Radon
2	R.A.	m	18	2	75	3	10	✓			10	X							–	✓	3	✓			✓		?	✓			1.7	0.0		
3	G.L.G.	m	48	1	79	18	25	✓			50	✓	10		✓	✓			?	✓	10	✓			✓		?	✓			3.6	3.8		Only One Cold Last Winter
4	E.C.	f	18	1	58	¾	25		✓		–	X							–	X							–		✓		2.4	2.8		
5	A.F.	m	45	1	36	1½	25		✓		–	✓	1½	✓					10	✓	1	✓				✓	–	✓			9.6	?		Great Relief from Colds
6	G.N.W.	m	29	1	36	2	25	✓			?	✓	2	✓			✓		?	X							–			✓	11.4	3.7		
MONEL METAL RADIUM APPLICATOR																																	
1	J.H.	f	30	4	30	2	25			✓	15	✓	2	✓				✓	50	X							–	✓			28.3	24.3		Measles 1yr. ago Worse Since, Now Hearing Hearing Aid
2	W.R.	m	40	2	24	–	0				–	✓	5		✓	✓			?	X							–		✓		1.8	0.7		Referred by Otologist because Audiogram Showed
3	A.R.S.	m	44	2	24	5	50		✓		–	✓	5			✓	✓		–	✓	6		✓			✓	–		✓		64.0	98.1		Impairment
4	S.S.	m	60	2	24	1	10	✓			?	✓	1		✓	✓			?	✓	1	?		✓			?		✓		34.4	33.0		
5	H.G.C.	m	55	6	24	2	25	✓			?	X							–	X							–		?		4.1	7.4		
6	W.R.P.	m	61	2	24	5	10		✓		–	✓	5	✓				✓	–	X							–		✓		18.8	16.5		
7	R.F.	m	39	1	24	¼	75	✓			25	✓	¼	✓			✓	✓	?	✓	¼			✓	✓		?		✓		16.2	12.6		One Previous Treatment at Mayo Clinic
8	H.M.	f	46	2	24	4	10		✓		–	✓	2		✓		✓		–	✓	?		✓	✓			–		✓		4.5	5.1		
9	E.R.G.	f	21	2	24	½	50	✓			40	✓	½	✓		✓		✓	100	✓	½	✓		✓			100	✓			21.1	2.5		
10	H.V.B.	m	46	3	24	10	75	✓			5	✓	10			✓	✓		25	✓	10			✓	✓		5	✓			82.9	79.1		Tinnitus Improved, can wear hearing instrument
11	I.J.B.	m	44	2	24	¾	25	✓			10	✓	¾			✓	✓		15	✓	¾			✓	✓		15		✓		21.4	14.0		with comfort
12	P.A.	m	53	2	24	5	50	✓			?	✓	¼	✓			✓		?	✓	⅛	✓		✓			?		?		14.3	18.2		
13	B.M.	f	34	6	24	¾	10	✓			?	✓	2	✓				✓	?	✓	?	?			?		?		✓		14.2	6.3		
14	C.T.	f	46	2	24	¼	25	✓			?	✓	⅛	✓		✓			?	✓	?	✓		✓			?		✓		13.3	6.0		
15	N.H.	f	57	2	24	3½	10		✓		–	✓	?	✓				✓	?	✓	?	✓				✓	?		✓		19.1	11.1		
16	L.D.H.	m	62	3	24	4	10	✓			?	✓	¾	✓		✓			100	✓	¾	✓		✓			75	✓			10.1	14.5		
17	F.G.M.	m	42	1	24	¾	10	✓			90	✓	5	✓				✓	?	✓	¾	✓		✓			100		?		5.6	5.6		Tinnitus Has Since Recurred
18	L.L.W.	f	37	1	24	6	?		✓		–	✓	3	?			✓		–	✓	?	?				✓	–	✓			3.3	3.1		Has Returned To Take Additional Treatments
19	H.L.B.	m	39	2	24	5	25		✓		–	X							–	✓	2	✓				✓	–		✓		7.8	5.1		For Relief of Tinnitus

| | | |

CHART II.

No. of Cases		Average Hearing Loss Before Irradiation Treatment	Average Hearing Loss After Irradiation Treatment	Average Difference
56	Total Series	17.2%	13.1%	4.1%
30	Males	20.5	17.5	3.0
26	Females	13.5	8.1	5.4

No. of Cases			Decades	Average Hearing Loss Before Irradiation Treatment			Average Hearing Loss After Irradiation Treatment			Difference		
Total	Males	Females		Total	Males	Females	Total	Males	Females	Total	Males	Females
6	2	4	21-30	14.3%	9.9%	16.5%	9.0%	4.2%	11.5%	5.3%	5.7%	5.0%
13	5	8	31-40	10.1	11.8	9.0	6.4	9.3	4.6	3.7	2.5	4.4
14	8	6	41-50	20.4	25.8	13.2	18.3	24.6	10.9	2.1	1.2	3.2
12	7	5	51-60	16.7	15.6	18.2	11.2	13.3	8.3	5.5	2.3	9.9
9	7	2	61-70	22.7	26.0	11.1	20.2	22.4	12.6	2.5	3.6	—1.5*
2	1	1	71-73	30.0	39.0	20.9	13.0	24.9	0.9	17.0	14.1	20.0

*loss

	MALES					FEMALES				
	AVERAGE					AVERAGE				
Decades	No. of Cases	Duration, Years	Impairment of Hearing Before Treatment	Impairment of Hearing After Treatment	Difference	No. of Cases	Duration, Years	Impairment of Hearing Before Treatment	Impairment of Hearing After Treatment	Difference
21-30	2	19.0	9.9%	4.2%	5.6%	4	1.1	16.5%	11.5%	5.0%
31-40	5	1.6	11.8	9.3	3.5	8	6.5	9.0	4.6	4.4
41-50	8	3.6	25.8	24.6	1.2	8	3.5	13.1	10.0	1.2
51-60	7	7.3	15.6	13.3	2.3	5	3.3	18.2	8.3	9.9
61-70	7	6.6	26.0	22.4	3.6	2	6.0	11.1	12.6	—1.5*
71-73	1	10.0	39.0	24.9	14.1	1	0.2	20.9	0.9	20.0

*loss

may be considered remarkable in a group of patients that should ordinarily have been expected to show a further loss of hearing.

Logically, sex should have no influence; and it is surprising to note that females appeared to respond to irradiation therapy better than males. Again, it would be expected that better results would be obtained in the younger patients; yet the breakdown into decades does not support that opinion, and the breakdown into sex and decades appears more confusing; however, in the breakdown for sex, decade and duration of symptoms, the first semblance of an acceptable pattern is found, and this would suggest that the duration of symptoms is the most important factor.

Reviewing the 19 cases showing greatest improvement reveals 11 reported the onset of symptoms one year or less prior to treatment. Cross-checking, it was found that 17 patients reported the duration of their symptoms before treatment to be one year or less; of these, 15 showed improvement, one no change, and only one reported further loss of hearing; neither sex nor age appeared to influence results. As Crowe[8b] stated, "Good results depend on early recognition and adequate but safe treatment before irreversible changes have occurred in the middle ear." It is realized that this series of cases is too small to justify many conclusions, but this study does indicate that the period of duration of symptoms is the most important factor in determining the reversibility of changes. Age appears to have less influence.

TINNITUS.

Tinnitus aurium can be, and frequently is, a most annoying symptom. Many and varied methods of treatment have been tried, including surgery, drugs, vitamins and dietary measures; none have been particularly effective. Polvogt,[9] in an unpublished paper, reports that in a group of 835 patients treated with radium, 97 of the patients' only complaint was tinnitus. He reports, "In 3 per cent of this group, the tinnitus ceased, and a number of patients said their tinnitus was a

great deal less. Three per cent is a very small percentage, but it is a group of most grateful patients; and it is worth trying, even if you get only 3 per cent cure."

Of these 56 cases, 49 complained of tinnitus. Their reports of the effect of irradiation of the nasopharynx are summarized in Chart III. It is feared these reports are "too good to be true." Tinnitus is a subjective symptom, and it is possible some of the patients may have been overenthusiastic in reporting their improvement. Again, this report covers only a total of 62 replies from 135 questionnaires; those who did not reply may not have had such good results.

CHART III.

Number of patients studied			56
Number of patients complaining of tinnitus aurium			49
Number reporting 100% relief	7	or	14.29%
Number reporting 50 to 90% relief	9	or	18.37
Number reporting 15 to 25% relief	2	or	4.08
Number reporting improvement but not estimating percentage	13	or	26.53
Total number reporting improvement	31		63.27
Number reporting no change	13	or	26.53
Number reporting tinnitus worse	4	or	8.16
Number not reporting	1	or	2.04
	49		100.00

In studying this chart to see if a "pattern" could be worked out, it was noted that six of the seven patients reporting 100 per cent relief had suffered with tinnitus for a period of one year or less; the seventh case had suffered only two years. Cross-checking, it was noted that 20 of the 56 cases had reported the onset of tinnitus one year or less prior to treatment. Of these 20, six reported 100 per cent relief; five reported 50 to 90 per cent relief; one reported 15 per cent relief, and five reported improvement but did not estimate the percentage. Only three reported no change, and none of the 20 reported their tinnitus worse! Again it appears that the duration of symptoms is the most important factor; the earlier the recognition and treatment, the better the prognosis.

PRESSURE.

The sensation of pressure may vary from a mild sense of fullness to a feeling of terrific pounding. The chief complaint of two of these patients was pressure (Cases 22 and 46). In some of these cases the Eustachian canals were completely blocked; in others, barely patent; however, there is a definite difference between the canals being barely patent on inflation and being normally patent. With present-day knowledge of the anatomy, physiology and pathology of the nasopharynx and Eustachian canals, and of the effect of irradiation on lymphoid tissue, it would logically be expected that adequate irradiation of the nasopharynx would aid in restoring and maintaining patency of the Eustachian canals, thereby relieving in whole or in part the sensation of pressure.

CHART IV.

Number of patients studied			56
Number of patients complaining of sensation of pressure in ears			41
Number reporting 100% relief	5	or	12.2%
Number reporting 50 to 75% relief	9	or	22.0
Number reporting 5 to 25% relief	3	or	7.3
Number reporting improvement but not estimating percentage	12	or	29.3
Total number reporting improvement	29		70.8
Number reporting no change	8	or	19.5
Number reporting condition worse	3	or	7.3
Number not reporting	1	or	2.4
	41		100.0

Forty-one of these 56 cases complained of pressure, and their response to irradiation treatment is presented in Chart IV. This indicates a very high percentage of relief. Again, it must be remembered that the sensation of pressure in the ears, like tinnitus, is a subjective symptom and is, therefore, subject to the same influences and variations discussed above.

In studying these cases, the same pattern of response was noted as in the studies of hearing and tinnitus. Fourteen patients reported 50 to 100 per cent relief; 12 of these reported the onset of their symptoms one year or less prior

to treatment. Cross-checking, it was found that of the 19 patients who reported the onset of the symptom of pressure in the ears one year or less prior to irradiation treatment, 18 reported improvement and one no change — and not one was worse! In considering the prognosis for the relief of this symptom, it appears that here, too, the important factors are early recognition and prompt treatment.

COLDS.

During the course of observation of these cases, several patients remarked that they had had fewer colds since the irradiation treatments. This question was, therefore, included in the questionnaire. Twenty-eight of the 56 (exactly 50 per cent!) reported fewer colds, 21 reported the same number, one reported more colds, and six expressed no opinion. In the absence of accurate records, these observations may not be reliable; yet it is not illogical to assume that the destruction of lymphoid tissue in the nasopharynx would eliminate a source of infection and thereby indirectly contribute to the raising of patients' resistance, or possibly destroy a trigger zone. Certainly this is not an undesirable effect of irradiation.

REMARKS.

Whereas, it is hoped this report will stimulate further studies in this field by many otologists, the warning of Crowe[8b] should be heeded: "If the occasional patient fails to respond as you had hoped, it is neither safe nor justifiable to continue giving larger and larger doses. Under no circumstances should a course of irradiation exceed four treatments in six weeks, and only in exceptional circumstances and on the advice of a radiologist should a second course of treatment be given within six months after the completion of the first course."

CONCLUSIONS.

1. Irradiation of the adult nasopharynx is beneficial in selected cases.

2. Better results are obtained when the radium is properly applied; and the author describes a method of insuring proper placing of the monel metal radium applicator in the nasopharynx.

3. To obtain good results, irradiation therapy must be administered before irreversible changes take place; successful management demands early recognition and prompt treatment.

4. In estimating the prognosis, the duration of the symptom is a more important factor than the age of the patient.

5. Irradiation therapy in selected cases offers better results in conservation of hearing and relief from tinnitus and pressure than any other current method of treatment.

APPENDIX A.

DRS. JONES AND HUME
Vicksburg, Miss.

June 16, 1947.

Dear

For the past few years we have been treating selected cases of impaired hearing with therapeutic applications of radium in the nasopharynx. You were given.....such treatments during.....

Of course, results were checked with hearing tests (audiograms), but I am now interested in learning the patient's reaction to, and opinion of, these treatments. Would you be kind enough to answer the following questions?

HEARING

1. How long had you noticed any impairment of hearing?.....
2. How badly did you consider your hearing impaired before treatment? (Circle one) 10% 25% 50% 75%
3. Immediately following the treatment, was your hearing (a) improved, (b) no change, or (c) worse?
(Please circle one; if change noted, please estimate percentage)
4. At present, compared to your condition prior to treatment, do you consider your hearing (a) better, (b) no change, or (c) worse?
(Please circle one; if change noted, please estimate percentage.)

TINNITUS (Roaring, hissing, singing, ringing, whistling, thumping or popping sounds in ear.)

1. Did you suffer with tinnitus before radium treatment?..... If so, how long had you noticed it?..... Was it (a) mild, (b) moderate, or (c) severe? (Please circle one.)
2. Since treatment have you noted (a) improvement, (b) no change, or (c) condition worse?
(Please circle one; if change noted, please estimate percentage.)

SENSE OF INCREASED PRESSURE IN EARS (Also described as "stuffiness" or "fullness," or as ears feeling "stopped up.")

1. Before treatment did you have a sense of increased pressure in your ears?..... If so, how long had you noticed it?..... Was it (a) mild, (b) moderate, or (c) severe? (Please circle one.)
2. If you had the sensation of pressure in your ears, after treatment was it (a) improved, (b) no change, or (c) worse? (Please circle one; if change noted, please estimate percentage.)

INFLUENCE ON COLDS

Since treatment have you had (a) fewer colds, (b) about the same number of colds, or (c) more frequent colds? (Please circle one.)

REMARKS (Please note any remarks you would care to make.)

I will greatly appreciate your filling out this questionnaire and returning it in the enclosed stamped, addressed envelope.

Sincerely yours,

EDLEY H. JONES, M.D.

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UNIVERSITY OF MINNESOTA COURSE IN OTOLARYNGOLOGY.

The University of Minnesota announces the sixth biennial Continuation Course in Otolaryngology to be held June 28, 29, 30, July 1 and 2. This course is designed to bring to the practicing otolaryngologist the newer concepts and developments in the specialty. The course will be under the direction of Dr. Lawrence Boies and associates of the university medical school. Dr. Harold I. Lillie, Dr. Gordon B. New and others of the graduate school faculty will participate in the instruction. Guest lecturers will include Dr. Kenneth Day, Pittsburgh; Dr. Gordon Hoople, Syracuse; Dr. C. Stewart Nash, Rochester, N. Y., and Dr. Francis LeJeune, New Orleans.

The fee for this course is $35.00. The enrollment is limited. Application should be made at an early date to the Director, Center for Continuation Study, University of Minnesota, Minneapolis 14, Minn.

ADENOIDS, THEIR VISUALIZATION AND REMOVAL.*

MERVIN C. MYERSON, M.D.,
Beverly Hills, Calif.

This paper represents a plea for greater attention to the adenoid operation. It serves to emphasize the importance of direct visualization of the nasopharynx during and immediately after adenoidectomy and the use of the best adapted instruments.

The evolution of our knowledge of the adenoids and their removal makes a fascinating story. According to Morell Mackenzie, Czermak was probably the first to see adenoid tissue. In 1860, he observed two small tumors at the upper part of the nasopharynx on the left side close to the opening of the Eustachian tube. Five years later, Voltolini reported a case of "stalactite-like growths projecting into the free cavity of the nasopharynx." These were destroyed with the electrocautery. It remained for Wilhelm Meyer, of Copenhagen, to describe accurately the clinical and microscopic aspects of adenoid tissue and to introduce a method for its removal. He called this tissue "adenoid vegetations." During the 20 years immediately following Meyer's publication, many laryngologists contributed to a better understanding of the subject; many of them suggested new methods of removal and new instruments.

The older textbooks mention removal or destruction of the growths. It is plain to see that adenoid vegetations were treated by many as though they were pathological growths, for it is not uncommon to read of electrocautery and chemical agents being employed for their destruction. In this respect the statement of Bishop (1898) is of interest: "While it is the practice of rhinologists to treat adenoids with washes, sprays, caustics and plain cautery, for periods ranging from four to 14 months, I much prefer the one precise operation lasting but five minutes."

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The first instrument used for the removal of adenoids was devised by Meyer. It consisted of a small ring attached to a slender handle. The inner edge of the ring was sharp. The author's description of the use of this instrument is as follows: "The instrument held in the right hand was inserted between the septum and the spongy bones as far as the posterior pharynx, with the knife perpendicular. The adenoid vegetation was cut off and expelled by a strong act of respiration." Soon there followed snares, Jarvis, Stoerk, Bosworth and others; electrodes by Lincoln and Robinson, forceps by Cohen and Lowenberg. These were modified by a large number of laryngologists, among whom were Mackenzie, Brandegee, Juracz, Quilan, Concannon, Curtiss, Schutz, Ruault, Nichols, Gradle, Butts. Finger curettes and knives carried on fingersheaths were introduced by Capart, Grayson, Dalby. Capart was the first to introduce a sharp spoon, much like the present-day bone curette, attached to a metal sheath on the index finger. Guye, of Amsterdam, first introduced the use of the finger nail for the removal of adenoids in 1880. Volkmann's curettes were attached to suitable, slender handles for introduction into the nasopharynx by way of the nose, being guided to the adenoid tissue by the index finger. The sharp spoons were modified until our present-day adenoid curette evolved. The first adenoid curette was that of Beckmann. This was improved upon by Gottstein and Hartmann, and later by Barnhill.

When one considers that most of the instruments and procedures were employed on adults in the precocaine days, one must marvel at the ability and perhaps the daring of the operators.

The present-day LaForce adenotome is the end-result of much modification. One can see that it gradually evolved from the caged curette. A blade was added, making it a guillotine much like that which had been in use for tonsillectomies.

Although it is the practice of most surgeons to make a digital examination before and immediately after adenoidectomy, it cannot be denied that visualization of the area is better.

Retraction of the palate to afford visualization has been practiced for many years. In 1900, White advocated the use of a catheter for elevating the soft palate. Thirteen years later, Joseph C. Beck introduced his technique of elevating the palate by means of a soft rubber catheter passed through the nostrils. This same technique, slightly modified, was presented by Gidoll some years later. Kelly so modified the LaForce adenotome that it permitted direct vision of the nasopharynx. At about the same time, Love introduced a soft palate retractor.

The instruments used for the removal of adenoid hypertrophy were quite numerous in the early days of this operation. Today, most surgeons us a LaForce adenotome or a modification and some type of curette.

Most laryngologists are not satisfied with the results of adenoidectomy. As Hill, Fetterolf and others have pointed out, the operation is usually done hurriedly, immediately after tonsillectomy, when the patient is frequently emerging from the anesthesia. In addition, the instruments employed may not always be the most suitable.

As a result of experience and some thought on the subject, I have come to use a modification of the Goodwillie palate retractor to afford visualization of the nasopharynx. The instruments used are forceps. They are modifications of the Ruault instrument. Three sizes are used; the largest is employed first to remove as much of the lymphoid mass as possible. After this instrument, the medium or smaller sized forceps are used as required. The palate retractor is in position at all times while the adenoid removal is in progress. A great advantage of this type of retraction is the ability of the laryngologist to use a hemostat on a bleeding point and so control bleeding more directly and efficiently in a large majority of cases.

It is hoped that this paper will once again make the otolaryngologist conscious of the importance of a good job well done when he contemplates adenoidectomy.

STREPTOMYCIN USED LOCALLY IN THE CARE OF CHRONIC SUPPURATIVE MAXILLARY SINUSITIS: REPORT OF A CASE.

NATHAN L. FINEBERG, M.D.,
Boston, Mass.

Streptomycin, when used parenterally, is an accepted therapeutic agent in the treatment of Gram-negative bacterial infections. On investigation, I find that few reports have been made on the local use of this antibiotic and that nothing has been written of its use locally in the treatment of infections of the sinuses due to Gram-negative organisms. (The use of streptomycin by any route raises the question of possible deafness; however, we have learned that, except in its prolonged use, there is no damage to the VIIIth nerve.)

In the past, radical surgery of the antrum insured the patient a cure in most cases. The case I present here is one of a cure without surgery and which is simpler in its management. The procedure itself is not new, as it has been used with penicillin by Sales[1] and Diamond, in 1944, who treated a chronic maxillary sinus infection with good results, using a spinal needle, which was left in place for 24 hours, for the frequent instillations of penicillin.

Priest,[2] in 1945, punctured the inferior meatus with a spinal needle and then introduced a segment of a urethral catheter through the cannula into the antrum for regular instillations of penicillin. He supplemented the local treatment with penicillin taken orally. The results were not encouraging.

Boyd,[3] in 1947, reported favorable results in 22 cases of chronic suppurative sinus infections when penicillin therapy was administered locally and parenterally in combination with simple or radical surgery.

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CASE REPORT.

The patient was a 30-year-old white female, who, early in a pregnancy, had the right upper wisdom tooth extracted; two weeks later, she complained of intermittent sharp pains over the right cheek. X-rays of the sinuses at that time were negative and, one month after the first extraction, the upper right first molar, which was abscessed, was also removed.

Discomfort of the right face continued and was accompanied by postnasal discharge of undetermined character, and at times she had blockage of the right ear. The teeth were again X-rayed and found to be normal. In view of the lack of other causes, the symptoms were attributed to the pregnancy.

When the patient came to my office shortly after delivery, she was still complaining of headache, pain over the right face and postnasal discharge, which by this time was purulent and made her breath foul. She had no soreness of the throat, no cough and no nasal obstruction or earache.

Examination revealed tenderness in the region of the right upper second molar and the gum margin was inflamed. There were no tonsils, but some lymphoid tissue was present along the posterior pharyngeal wall. The septum was deviated to the right, anteriorly, with about three-fourths obstruction of the right airway. The left side was clear. There was occlusion of the right middle meatus, but no purulent discharge was seen. Both drumheads were normal in color. No light passed through the right antrum on transillumination and X-rays of the sinuses showed marked cloudiness of the right maxillary sinus with retained secretions (see Fig. 1).

Under local anesthesia, supplemented by inhalations of Trychlo,[4] the right inferior meatus was punctured with a Coakley trocar, thus entering the maxillary sinus, which was irrigated with normal saline. Foul green pus was obtained, a culture taken, and 5 cc. of a solution containing 200,000 units of penicillin was instilled. Bacteriologic studies revealed a pure growth of alkaligenes fecalis. The patient was referred to her dentist because foul discharge and pain over the right upper

jaw would sometimes indicate an infection over the tooth, extending into the antrum. The dental examination was negative.

Symptoms persisted for three weeks longer. During this interval the same procedure was carried out three additional times. The culture made from the antrum washings now showed not only alkaligenes fecalis but also proteus vulgaris

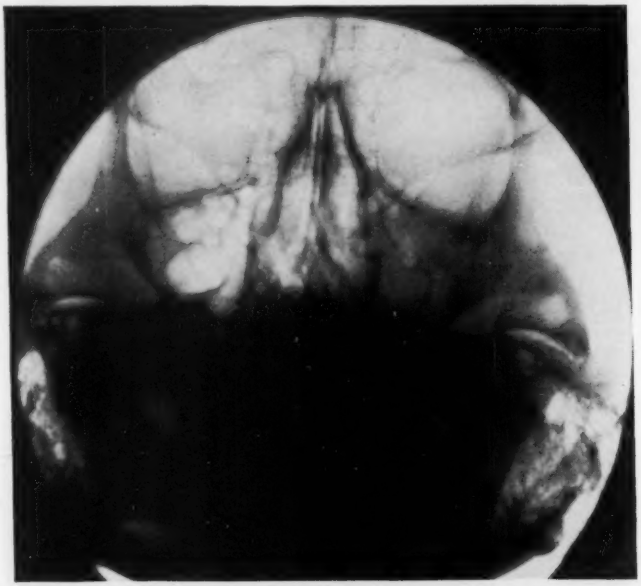

Fig. 1.

and E. coli. The patient was complaining of nausea, postnasal purulent discharge, discomfort of the right upper jaw and a foul taste in her mouth, and she was admitted to the hospital for local treatment with streptomycin.

Under local anesthesia the antrum was punctured with a Coakley antrum trocar and irrigated with normal saline. A

urethral catheter was put through the cannula into the antrum by way of the inferior meatus (see Fig. 2). Five cc. of streptomycin solution containing 2 mg. per cc. were instilled directly into the maxillary sinus and the catheter taped in place for similar instillations every 12 hours.

Fig. 2.

The following day there were no complaints of postnasal discharge or nausea, and the pain over the right face was considerably reduced. The antrum was irrigated with saline through the retained catheter, but very little discharge was

obtained. Instillations of streptomycin were continued every 12 hours. A culture taken at this time showed no Gram-negative bacilli.

Three days after hospitalization and treatment, the patient was free of symptoms: the nausea, pain, tenderness and postnasal discharge were gone and the irrigation of the antrum produced but a few flakes of mucoid discharge. The appetite was much improved and she was very happy to be symptom-free for the first time in almost 10 months.

The following day, mucopurulent discharge was obtained and the culture at this time was reported as showing only staphylococcus aureus in large numbers. The catheter was removed and the patient sent home, with instructions to return to my office for continued treatment with pencillin. Irrigations with saline and instillations of 200,000 units of penicillin dissolved in 5 cc. of saline were carried out in the office on two successive days, and on the third day the patient complained of a sore throat, backache and occlusion of both airways. The temperature was 101°. She was given nose drops, gargles and emperin compound with codeine.

One week later there was no further purulent discharge, nausea or pain over the face and head. The right antrum was again punctured and irrigated and the return flow was clear. Penicillin was instilled for the last time. The culture was sterile.

For two months the patient continued without complaints, and X-rays of the sinuses were entirely negative (see Fig. 3). A submucous resection of the septum was recommended and the patient discharged as cured.

Summary and Comment: We have presented a case of chronic purulent maxillary sinusitis due to alkaligenes fecalis which was treated successfully with local instillations of streptomycin through a retained urethal catheter. It is interesting to note that after the infection with the Gram-negative bacteria was eliminated, a new process due to Gram-positive organisms became apparent and was treated successfully with penicillin. It is of fundamental importance in the management

of these cases to have close cooperation with the laboratory. Bacteriological studies of sinus secretions are necessary to determine the chemotherapeutic agent to be used. I agree with Crowe[5] and his co-workers that penicillin used topically in sinuses has great tissue penetrating power: streptomycin also appears to have the same penetrating qualities. The effect of streptomycin on the cilia is unknown.

Fig. 3.

The method of treatment described in this paper has the following advantages over the Caldwell-Luc sinusotomy: *1*. It is simple. *2*. All structures of the maxillary sinus remain intact, but the bacterial infection, as proved by the cultures, is eliminated. *3*. Patients prefer this method from a physical and economical standpoint.

I have used this method in many cases of maxillary sinus-

itis chronically infected with Gram-positive bacteria with good results and shall now continue to use it in not only these but also infections due to Gram-negative organisms, in which only radical surgery has been used in the past.

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The Home Study Courses sponsored by the American Academy of Ophthalmology and Otolaryngology, in the basic sciences related to these two specialties, will be given again, beginning Sept. 1, 1948. Registrations must be completed before Aug. 15. Detailed information may be secured from Dr. William L. Benedict, Executive Secretary, 100 First Avenue Building, Rochester, Minn.

A REVIEW OF RECONSTRUCTIVE SURGERY OF THE FACE — 1947.*

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This paper is a review of the literature on plastic and reconstructive surgery of the face for 1947. Much of the published material of this early postwar period has dealt with the treatment of wounds and methods of repair of defects resulting from global warfare. This year, however, an increasing number of pages are devoted to the surgical problems of civilian practice, and special attention is drawn to the applicability of war experiences and procedures to this practice.

COMPOSITE GRAFT.

Brown and Cannon[14] describe the use of a free composite graft obtained from the ear and composed of two surfaces of skin and intervening cartilage. The composite graft makes it possible to transfer in a single operation a comparatively large bulk of tissue which is highly suitable for the repair and reconstruction of the nasal tip, columella and ala.

The graft is readily obtained from any area of the ear where cartilage intervenes between two surfaces of skin. The helix and the crus of the helix are most frequently used. The cartilage imparts the necessary form and stability to the graft. It makes such a graft possible by maintaining an internal stretch of the skin, while the vascularity of the graft is being established. The recipient area must be carefully prepared. Wide dissection provides an adequate minute blood supply to meet the early metabolic requirements of the graft. The defect of the ear is easily repaired by direct closure, local flap or adjacent direct scalp flap.

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At operation the scarred defect is completely excised. The graft is cut to pattern by careful through-and-through incisions. Special care is taken not to disturb the relation of skin to cartilage. The graft is then sewn very accurately into the defect with fine interrupted silk stitches around all raw edges. The nares are packed, and a firm pressure dressing is applied to the nose. The donor site is then repaired.

Losses about the tip of the nose, the ala and the columella are the ones for which the graft was originally designed and perhaps best adapted. It is to be expected, however, that the use of the composite graft will be extended and its indications increased as larger grafts are found possible. This free transplantation of a large bulk of tissue may be expected especially to find application in the restoration of other facial features. Already their use for the correction of deformities associated with cleft lip is under investigation; and they have been used in the repair of eyelid defects. In a subsequent article, Brown, Cannon, Lischer and Davis[12] have further described their experience with the composite graft.

Cannon[25] presents the more important methods of plastic surgery that were developed or perfected during World War II. He stresses particularly the use of composite free grafts from the ear in the repair of losses of the ala, columella and tip of the nose. Results with composite grafts are superior to all other methods. They match the normal nasal borders in color, texture, contour and appearance.

FACIAL INJURIES.

Brown and Cannon[17] present the salient problems and important factors in the care of patients with major facial injuries. They result most frequently from burns, traffic accidents, radiation exposure, gunshot wounds and freezing. The recognition of lost and displaced tissue, and the evaluation of distorted function, form highly important components of the diagnosis. Cutting debridement or opening packing of facial wounds is never indicated. Gas gangrene rarely, if ever, occurs and irreplaceable facial features may be needlessly sac-

rificed. It has been shown repeatedly that if severely lacerated faces are promptly and judiciously repaired, an excellent result can often be accomplished in one single immediate operation; indeed, the result obtained in such an early operative repair, and without cutting debridement or opening packing, may not be duplicated in 20 or 30 later procedures. It is essential to apply a pressure dressing following facial injury and repair.

The normal face requires protection for the eyeballs, a mouth for eating, and a nose for breathing. These basic needs demand first consideration. The restoration of a badly mutilated face may be accomplished by the utilization of local tissue providing distortion of adjacent features and interruption of nerves does not result. New tissue may be added in the form of free split thickness grafts, full thickness clavicular grafts, composite grafts, flaps, bone, cartilage and fascia transplants. The patient is an individual and must remain so through the cooperative efforts of the ophthalmologist, rhinologist, dentist and plastic surgeon.

Alexander[5] gives a very good comprehensive resumé of some 421 maxillofacial battle casualties seen by an auxiliary surgical group attached to one of the U. S. Armies. The paper draws attention to the basic principles involved in the management of compound facial injuries and stresses the importance of early repair and conservation of all viable tissue. Emphasis is placed upon preservation of an adequate airway, restoration of the mandibular arch and safe evacuation of the patient.

Iverson[49] stresses the importance of the initial care of traumatic tattoos of the face. Careful scrubbing of the initial lesion and irrigations of warm saline will most frequently prevent future cosmetic blemish. Once the wound is healed, however, surgical procedures are necessary for the correction of the disfigurement. The highest percentage of foreign materials is usually found within the dermal layer. Ordinary carpenter's sandpaper, grit 0 and 00, is sterlized. When the involved area has been surgically prepared and local anesthetization carried out, the skin is vigorously abraded — stop-

ping short only of the full thickness. The normal surface epithelium is then again able to regenerate from the sebaceous glands and hair follicles. It has been found safe to carry the procedure to the point where the subcutaneous tissue gradually makes its appearance in small pin-point elevations of fat. Normal epithelium will cover the area in approximately 10 to 14 days. This covering at first appears erythematous, but in time fades and blends with the normal surrounding skin.

Abbott[1] surveys the history of the bayonet and its use in warfare. He found only five penetrating bayonet wounds of the head recorded in the Surgeon General's report of the Civil War. Only one such case is reported in World War I. Abbott gives the case history and operative data of five additional cases seen in the recent conflict. The infrequency of such wounds is attributed to the fact that the bayonet is generally thrust into the chest or abdomen.

Peacher[80] enumerates the many speech disturbances resulting from maxillofacial injuries acquired in World War II, and discusses the necessary rehabilitation. Young[104] reviews 157 cases of maxillofacial fractures observed in an army hospital and outlines the general plan of treatment. Kanthak and Dubrul[50] relate their experiences with the immediat repair of war wounds of the face. Straith and Pilling[99] include compound facial injuries in their discussion of plastic surgery as related to industry. The care of fractures of the facial bones is considered. The early and late care of burns is briefly discussed. Klein[56] offers a classification of maxillofacial injuries. Friedman[41] enumerates the causes of acute respiratory obstruction, the signs of such an obstruction and the indications for tracheotomy. The anatomy of the neck as it relates to tracheotomy is reviewed; the operative procedure is given in detail. Conway and Hendricks[30] describe the late definitive treatment of gunshot wounds of the head.

EYELIDS AND ORBIT.

Cannon[25] points out the decided superiority of full thickness grafts obtained from the base of the neck for resurfacing the

eyelids. The color match is good. The presence of the platysma muscle in the subcutaneous tissue of the clavicular region seems to impart peculiar qualities of delicate texture and functional mobility to the skin. This is coupled with a minimal shrinkage common to the full thickness graft. Schenck[87] resurfaces the orbital floor with large mucous membrane grafts. The inferior turbinate as a source of such large area mucous membrane grafts is emphasized.

Schuessler and Filmer[88] suggest certain disadvantages to the customary method for restoration of the cilia. This usually consists of transplanting a free hair-bearing graft horizontal to and including a portion of the lower part of the eyebrow. Many people do not have hairs in this region which are spaced like eyelashes. In other people, the hairs even at the nasal end of the brow maintain a temporal rather than an upward direction. In those individuals in whom it is necessary to provide cilia, the eyebrows are often destroyed in the medial aspect, and thus are not available as a donor site. It has been found highly satisfactory to use a free hair-bearing graft taken vertical to and through the eyebrow. The hair spacing and the direction of the hairs is more like that of the normal eyelashes. To carry out this procedure, a free hair-bearing graft about 3 mm. in width is taken vertically through the eyebrow. Such a graft contains three or four rows of hair. The section is lifted from the eyebrow and placed in the defect along the lid margin. Special attention is necessary to see that the hairs are placed in the direction of the normal eyelashes. The graft is sutured and stinted into position with fine silk. Frequently the hair in the graft will fall out. Commonly the marginal rows do not regenerate, leaving only the more central row to grow. Thus an even better cosmetic result is obtained. A pressure dressing is removed after one week.

Spaeth[95] divides upper eyelid repair into two major divisions: reconstruction when a functioning eyeball is present, and when the socket is surgically anophthalmic. It is necesary to consider whether the defect is a result of the loss of the external portion of the lid, of the conjunctiva, or a combination of these. The functioning eyeball demands the use of

conjunctiva or mucous membrane for the reconstruction of the posterior surface of the lid. An epithelial-lined surface may be used in the repair of the anophthalmic orbit. A knowledge of the anatomy of the lid is important for its successful restoration. The lower eyelid is utilized in the reconstruction of the upper lid in the presence of a functioning eyeball. Additional techniques are considered for those cases in which the globe has been removed. Epithelial lining of the inner aspect of the lids, pedicle flaps or free lined grafts may be used for total lid reconstruction in the anophthalmic case. In conclusion, Spaeth emphasizes the importance of doing simple repairs, scar excisions and resuturing if such procedures will correct the existing defect.

Sherman,[92] in a discussion of reconstruction of orbital defects, stresses the early reduction of fractures of the floor of the orbit. When late reconstruction is necessary, he uses acrylic implants on the depressed floor to elevate the contents. Large losses of the lower orbital border are reconstructed with cancellous iliac bone. The smaller losses are repaired by a fascia lata graft. Acrylic implants and cancellous bone grafts are believed preferable to cartilage transplants or performed tantalum plates.

Fox[39] gives a brief historical account of the use of preserved cartilage in plastic surgery; its advantages are subsequently enumerated. This material is used to replace lost torso cartilage in the repair of eyelids. Bony orbital defects giving unsightly depressions and disturbances of contour may be corrected by implanting preserved cartilage. The downward displacement of orbital contents resulting from a depression of the orbital floor may be elevated by transplanting cartilage into this area. Preserved cartilage finds particular use in the correction of defects resulting from old orbital fractures.

Spaeth[94] reviews the methods available for correction of acquired ptosis. Kiskadden and McGregor[55] describe and illustrate a method for the correction of colomba of the eyelids. Pickrell and Clark[82] offer a method for the tattooing of corneal scars with insoluble pigments.

SKIN GRAFTING.

Brown[20] points out that in the Medical Department report of World War I, some 300 pages deal with plastic surgery without mentioning free skin grafting except for one suggestion of a small oral graft; furthermore, the treatment of burns is not considered. In World War II, approximately one-third of reconstructive surgery consisted of the treatment of wounds by free skin grafting. A large amount of work was done in the repair of burn defects. Special mention is made of the treatment of contractures following burns in which the eyeball is left exposed and vision endangered. Satisfactory results have been obtained in hundreds of instances by the use of free skin grafts to resurface the lids, thus providing adequate protection for the eyeball. The free full thickness graft obtained from the clavicular region has been found especially useful since there is a large amount of available skin which is of particularly suitable texture and provides a good color match.

Figi[38] reviews the cases of nasopharyngeal cicatricial stenosis seen at the Mayo Clinic. The various procedures used for their correction are outlined. He presents a method of relining the scarred nasopharyngeal lumen with a skin graft, utilizing a self-retaining obturator to maintain the patency of the opening. Douglas W. Macomber and Wynn[60] relate their experiences with 100 free full thickness grafts and emphasize points of particular importance for the success of this type of transplantation. Steinreich and Callahan[97] report a case of a burn in which reconstruction of the face and eyelids is described in detail.

FACIAL PARALYSIS.

Brown and McDowell[16] use the temporal muscle and its fascia to support the face when the VIIth nerve is paralyzed or cut. Loops of fascia lata connect the temporal muscle and the face in the region of the mouth and the columella. By adjusting the loops to the proper length, the nasolabial fold is re-created. A small amount of movement may be produced by

the temporal muscle. This operative procedure is indicated in any permanent paralysis of the facial nerve when nerve grafts, anastomoses or direct suturing are impossible, or when these have been attempted and failed. It may also be used in conjunction with any of these nerve operations. The procedure is carried out under endotracheal anesthesia. Strips of fascia lata, 4 to 8 mm. wide, are obtained from the iliotibial band. A temporal incision is made in the hair-bearing area and extended down to the temporal fascia. A very small incision is made in the central portion of the upper lid, and another just medial to and below the corner of the mouth. The first strip of fascia lata is then threaded subcutaneously from the temporal region out through the stab wound in the upper lip and back up to the temple; a large amount of soft tissue is thus encircled. The second strip is likewise passed from the temporal area to the lower lip and back. The slack is then worked out of the strips. An incision about 2.5 cm. long is made in the temporal fascia. The strips are threaded through the muscle. Knots are tied, shortening the fascial loops sufficiently to overcorrect the mouth considerably. Several interrupted sutures fix the knots. Incisions are carefully closed in layers, and a pressure dressing is applied. Five or six days of hospitalization follow. At the end of about three weeks' time the overcorrection has disappeared and the patient is started on a series of exercises which place emphasis on the balance of the face rather than the range of motion obtainable. Autogenous fascia is preferred to preserved fascia, kangaroo tendon or wire. Upper eyelids seldom require treatment. The general elevation of the face usually helps to correct any sagging of the lower lids; however, if this does not elevate the lower lid sufficiently, a small external canthoplasty is carried out. Occasionally a thin fascia strip is passed horizontally through the lower lid, suturing it to the temporal fascia above and to the frontalis fascia or muscle medially.

"Among the advantages of the operation may be listed *a.* its simplicity and directness; *b.* its early, definite results; *c.* the absence of resultant annoying tics or mass actions and the

minimal possibility of complete failure; *d.* it can be used later when nerve operations have not been as successful as anticipated or desired; *e.* it can be used in conjunction with operations on the nerves; *f.* it can be used in practically all patients, regardless of the cause or duration of the paralysis; and *g.* it does not produce any additional disability or visible scars."

Kettel[54] relates that, in 1932, Ballance and Duel first operated on a series of patients suffering from Bell's palsy. The Fallopian canal, from the stylomastoid foramen to the lateral semicircular canal, was opened and the facial nerve decompressed. It was felt that the disease was due to edema of the facial nerve compressed in its inelastic bony canal. Ballance and Duel obtained beautiful results by this procedure. A decompression should be done on those patients who show no sign of beginning mobility after a period of two months' conservative treatment. The procedure should also be carried out in cases in which recovery of mobility ceases before complete restitution. Relapsing paresis also is an indication for decompression.

Owens[77] reports 11 cases of the correction of facial paralysis with fascial strips and finds it the most satisfactory available procedure. Schultz and Fowler[89] enumerate the advantages and shortcomings of the use of tantalum wire in the correction of facial paralysis. They find tantalum gauze to be a distinct adjunct to this procedure. In many cases the mere insertion of such gauze into the cheeks and lips provides sufficient support. Wires extending from the gauze to the temporal fascia are then unnecessary. Seeley[90] discusses the anatomy and reviews the literature on the dehiscent parotid duct and facial nerve. He reports a case in which the duct was successfully repaired and a facial nerve preserved by an inlay nerve graft.

Adams[2] utilizes multiple muscle transplantation in his correction of facial paralysis. The masseter muscle serves best for reanimating the corner of the mouth and the lower portion of the face. The temporal muscle is transplanted to restore support and function to the upper and lower eyelids.

If the frontalis muscle of the opposite side is especially active, a portion of this muscle is transplanted into the upper paralyzed lid. The details of the operative procedure are given, and case reports are presented. Dr. Kitlowski, in a discussion of this paper, expresses the opinion that the procedure is hardly worthwhile. With the passage of time, there is so much fibrosis that the muscle transplants act simply as straps. The simpler technique of fascia transplantation will serve the same purpose well. Dr. Kitlowski based his statements on cases in Lexer's Clinic where muscle transplantation procedures were first carried out in VIIth nerve paralysis.

NOSE.

Byars[23] deals thoroughly with the correction of the more common nasal deformities. Most rhinoplasty procedures are based upon an alteration of the size, shape and inter-relationship of the component parts of the nose. The bony structures, lateral and alar cartilages, columella, mucosa, subcutaneous tissue and skin are described. "The cartilaginous septum is the ridgepole which gives height to the lower two-thirds of the nose, supplies support to the other cartilaginous structures and oftentimes causes a shifting from the midline of the external nose when it has been displaced by trauma. The septum is the one structure most often deformed and the one interfering with the function of the internal nose."

The patient's facial features and, indeed, the whole patient, must be considered whenever any change in nasal appearance is contemplated. An osteoplasty to remove a nasal hump will rarely, if ever, suffice. Other faults are accentuated. Other nasal components must usually be changed. Other facial features must occasionally be altered. The nose may be narrowed or shortened; the tip may be modified. A receding chin may require a cartilage transplant.

The standard corrections which make up the usual rhinoplastic operation are described and depicted in detail. Special paragraphs are devoted to the hanging columella, secondary corrections, external excisions and septal resections. The cor-

rection of a snub tip and retrusion of the middle portion of the face necessitates the advancement not only of the nasal tip but of the entire upper lip. The soft tissues upon which the nose rests are thus brought forward. This deformity must be very definitely overcorrected in order to compensate for the settling of the tissues which ensues in the first few postoperative weeks. The nasal deformities associated with cleft lip are fully discussed. The necessary modifications of the usual rhinoplastic procedures to correct these variations are outlined. The restoration of nasal symmetry in the double cleft lip case offers considerable difficulty, and the problem is frequently complicated by an almost complete absence of the columella. Operations to correct post-traumatic deviations of the external nose from the midline are described. The depressed nose is elevated by means of a cartilage transplant.

Steffensen[96] reviews the methods available for the correction of deviations of the anterior-inferior margin of the septum and warns particularly against the injudicious use of submucous septal resections. The method of Metzenbaum has been used in 311 cases and has given uniformly good results. Certain refinements of the original method are described.

Eisenstodt[33] discusses the management of septal deformities and advocates submucous resection for about 80 per cent of the cases in which a rhinoplasty is done. Milder and moderate vasorhinitis may be improved or completely cured by submucous resection and rhinoplasty. If the dorsal septum caves in as the result of undue surgical trauma, the defect should be immediately corrected by suturing the fractured ends together, suturing the upper lateral cartilages over the dorsum, inserting cartilage or bone into the dorsum, or pinning the septum in place. The incision for a submucous resection should always be sutured closed when this procedure is done in connection with a rhinoplasty.

Cohen[27] reviews the normal and pathological anatomy of the dislocated septal cartilage. The relation of the lateral and alar cartilages and columella to this defect is described. Two procedures are given for the correction of more advanced dislocations: the method of Metzenbaum and the author's rhino-

plastic method. This operation may be carried out in very young children.

New and Erich[73] describe an acrylic obturator employed in the repair of an obstructed frontonasal duct. Brunner and Donnelly[21] discuss nasal and auricular fistulae in their relation to a specific case.

Oldfield and Roberts[76] review the technique used in the reduction of nasal fractures and describe the several commonly available splints. They describe a newly designed splint which has a nasal cap splint attached to the maxillary teeth for rigid fixation. Ulloa[100] treats nasal fracture with a personally designed rhinotractor.

Eisenstodt[34] gives a didactic and surgical classification of the underdeveloped chin and discusses the relationship of rhinoplastic surgery to this feature. He reports on 31 cases in which microgenic chins have been corrected by preserved cartilage transplantation. Their recovery following the procedure has been uneventful. The results have been gratifying. Among possible complications, he includes perforations into the oral cavity, graft displacement, infection and vesicular dermatitis.

Daley[31] draws attention to the importance of columella and septocolumella sutures in rhinoplasty. He discusses the orthopedic suture of Joseph, columella belly suture, submerged perforating suture, straight septocolumella suture, ventral septocolumella suture, straight columella suture and the perforating implantation suture. Salinger[86] reconstructs the columella with a tubed flap from the neck paralleling the sternomastoid muscle. It is not usually necessary to use cartilage to stiffen the new structure. Griesman[45] describes the effect of a typical nasal plastic correction on facial expression.

Pearlman[81] discusses the artistic conception of form, proportion and harmony as they apply to the nose and its relationship to facial contours and expressions. Case histories are given and photographs are provided to illustrate the various features considered. A case of identical twins is depicted, in

which osteoplasty on the nose was carried out; the importance of similar results is stressed.

In a series of 200 cases of rhinoplasty, Ersner and Alexander[37] used vitamins K and C routinely, reducing primary bleeding and eliminating late secondary hemorrhage. Sulfadiazine was regularly given, and in no case was slough or infection encountered. For hypothyroidism, thyroid extract was used.

Kazanjian and Holmes[52] describe a new rongeur for the removal of the nasal hump. Gatewood[42] substitutes the chisel for the saw in osteoplasties of the nose. Hebert[48] has designed another external nasal splint. Popov[84] writes of the incidence, causation, signs and symptoms, pathological aspects and treatment of myiasis of the nose. Adolph M. Brown[11] advocates the use of sculptured synthetic prostheses; their preparation is outlined, and their use in defects of the nose is illustrated.

Safian,[85] who has performed thousands of rhinoplasties, reviews critically a number of the more recent articles concerning this subject. The most common fallacy appearing in the literature deals with the "tie in" theme. This theory places great stress on art, mathematics and microscopic anatomy as they relate to rhinoplasty. He cites Griesman's paper on the muscles and cartilages of the nose as "an excellent resumé of the works of various anatomists, and defines minutely the actions of the different muscle fibres about the nose." Safian believes the musculature of the nose is insignificant from a practical standpoint and may be entirely ignored in the performance of osteoplasty on the nose. He finds it impossible to carry out techniques designed to preserve muscle fibres of the nose; indeed, he says he has never seen a nasal muscle in the course of a rhinoplasty. Safian contends that when the nasal hump is removed, the overlying periosteum should be removed with it unless the surgeon desires regeneration of bone. The bony dorsum should not be undermined subperiosteally to preserve the procerus muscle. Safian does not agree with Ersner that it is the rhinologist's duty to correct a cosmetic defect on the nose as a part of his intranasal work.

Several articles reviewed by Safian introduce numerous anatomical terms for the components of the nose. A plea is made for use of the simpler internationally standardized terminology. Safian feels that "the artistic point of view in rhinoplasty has been exaggerated and misinterpreted to such a degree that the public is given the false impression that it is within the power of the plastic surgeon to create lines and facial effects such as are seen in the works of the world's most renowned artists."

Commenting on an article by Fomon, *et al.*, in which "the authors go on to prove by means of a mathematical formula that the septum is a superfluous structure which serves no purpose whatever, except possibly to provide patients for rhinologists" and in which they "advocate a dangerous procedure when they advise the complete removal of a septum," Safian writes that "as to the mathematical formula by means of which they feel that they have proven the septum to be an unnecessary structure, I am quite certain that in the near future someone will come forth with a more involved formula which will establish the fact that the entire external nose is a superfluous and redundant member."

Safian is "particularly concerned with the attempt of a group of men to create a synthetic literature. Their writings, which are finding their way into medical journals, are constantly growing more complicated in their verbiage, more faulty in their conclusions and more dangerous in their teachings."

EARS.

Brown, Cannon, *et al.*,[19] offer a plan for the rapid restoration of the external ear. This does not involve the use of distant flaps or numerous operative procedures. The method consists simply of opening and excising the scarred areas from the edges of the remaining ear stump; this edge is in turn implanted in a scalp flap raised above and behind the ear. In two or three weeks, when the wound is healed, a piece of preserved cartilage carved to the desired shape is inserted under the flap. In approximately four weeks incisions are well healed and all edema has subsided. The cartilage and covering

flap are then dissected free of the skull. A soft tissue layer must be left, enclosing both surfaces. Special care must be taken not to expose the cartilage. The two raw surfaces are at once covered with a single split thickness graft. This plan is adaptable to the restoration of losses of pinna and helix as well as total ear reconstructions. If the hairless area about the ear stump is too limited or the tissue is densely scarred and discolored, the bed must first be prepared by excision of the undesired tissue and skin grafting. A flap may be required to prepare the bed when the tissue in the local area has been completely avulsed.

Aufricht[6] offers a procedure for the total construction of an ear. Although the exact configuration of the ear presents one of the most difficult objects for reconstruction, it is felt that a deep, spacious concha is a most important feature in creating a normal looking ear. The new ear is made by closely following an acrylic model patterned after the ear of the opposite side. The pinna is considered to be a large semicircular body, rather than a mere shell. A cartilage form to meet these specifications is provided either by molded cartilaginous chips or by a massive cartilage block. It is buried subcutaneously for a period of four to eight months. In the interim a large postauricular flap is prepared, which includes a portion of the hair-bearing area. This must provide sufficient soft skin to cover the many configurations of the ear. The molded cartilage or cartilage block is then transplanted beneath it, taking great care to position the transplant accurately and artistically. When the cartilage is covered with the skin flap, the scalp incisions will be too wide to close primarily. A split graft is used to cover this defect. In a month to six weeks the concha is created by removal of cartilaginous elements in that area. The skin covering is inverted to form the lining of the concha. A small skin graft may be necessary to complete this structure. In another four to six weeks the skin and cartilage are elevated from the scalp, and the denuded areas are covered with a fairly thick dermatone graft which is stinted into position. The hair-bearing skin which covers the pinna may

be removed either by epulation or by surgical resection. A clavicular skin tube is used to prepare the helix.

The early attempts of Pierce, Klabunde and Bergeron[83] to repair outstanding ears were not satisfactory because the excision of an ellipse of skin and cartilage from behind the ear resulted in a sharp ridge and abnormal contour. Outstanding ears lack the normal antihelix fold and do not assume their position because of too much cartilage. Eight or 10 parallel incisions through the cartilage in the position of the desired antihelix create a gross replica of a normal fold. An ellipse of excess skin is removed. The ear is tacked back by fine catgut stitches and the skin closed with a running Dermalon stitch. The ears are then dressed with light pressure.

Cannon,[25] in his discussion of some of the more recent advances in plastic surgery, stresses the importance of the repair of defects of the ear with local tissue, preserved cartilage and skin grafts. McEvitt[69] reviews the anatomy, embryology and etiology of prominent ears and offers a classification of the various deformities encountered. Corrective methods are mentioned, and the operative procedure used by the writer in the correction of the more common types of defects is discussed. Weaver[102] has outlined briefly his correction of prominent ears. Seltzer[91] stresses the importance of outstanding ears and reviews the various operative procedures designed for such correction. Franklyn[40] describes the correction of protruding ears.

CLEFT LIPS AND PALATES.

Brown, McDowell and Byars[15] describe fully the surgical principles and operative details involved in the repair of double cleft lips. The frontonasal process which normally fuses with the maxillary processes develops independently and produces a bilateral cleft and marked growth distortions of the middle third of the face.

A double cleft lip makes for a difficult feeding problem and constitutes a very decided psychic trauma to the parents; early closure is thus necessary. The operative procedure is

of the first magnitude and the preoperative preparation is important.

The significance and types of premaxilla are described. This structure is not set back if the lip can be closed over it unless it is markedly tilted or rotated, or if the pressure of the closed lip will cause the septum to buckle. The prolabium must be used to form the central portion of the lip. To include the vermilion in the repaired lip nearly always results in a double notch. A plan which involves turning back the entire prolabium vermilion to be utilized for lining if needed appears best. The commoner designs embody many of the features of the modified Mirault operation for single clefts. If the primary operation is well planned and executed, there will be fewer secondary adjustments necessary. In those children with practically no columella subsequent elongation will be needed. A cartilage transplant may be indicated for further elevation of the nose. Those children with accompanying cleft palates will require not only the cooperative efforts of the dental and plastic surgeons, but also the concerted effort of the speech trainer and otolaryngologist.

In general, tonsillectomies and adenoidectomies should not be done unless necessitated by the patient's general health or hearing. These patients should be followed and examined periodically throughout childhood by the surgeon. Every effort should be made for their maximum rehabilitation.

Kazanjian[51] elaborates on the more common secondary deformities developing in the cleft lip and palate case. A slight receding upper lip and overdeveloped lower lip is most common. Within the mouth the underdeveloped and distorted maxillary bones and the irregularity of the teeth is marked. A distorted ala, blocked airway and short columella are not uncommon.

In the correction of such cases the first step is to provide a suitable temporary (denture) or permanent support for the upper lip. The second step is to switch a flap from the lower to the upper lip after the manner of Estlander and Abbe. The

operation in the single cleft lip is given in detail, and a method to elevate the tip of the nose is presented pictorially.

Vaughan[101] considers the problems of congenital cleft lip. He describes the deformity and the anatomical structures involved. The preoperative and postoperative care are outlined. The technique used to repair single and double lips is discussed and illustrated in detail. In the repair of the single cleft lip, he stresses the necessity of having the repaired site match and harmonize with the normal side. He believes that it is most important in the repair of bilateral lips to use the prolabium and philtrum to the fullest extent in order to avoid long vertical and short transverse lips. Conservation of the premaxilla is equally important for support of the lip.

May[68] has described Axhausen's method for cleft lip repair in four steps: formation of the floor of the nostril. correction of the alar displacement, correction of the septal displacement, and closure of the lip.

Oldfield[75] believes the main disability of the cleft palate patient is the defect in speech. The repair of the palate and nasopharyngeal valve is the first stage of treatment. It is the responsibility of the surgeon to supervise the after-care until normal speech has been attained. The functioning of normal speech is described; a radiographic method of demonstrating the position of the soft palate, lips and tongue during the articulation of speech sounds is given. Cleft palate speech defects are enumerated. The methods of postoperative speech training are given. The companion part of this paper, which was delivered as an Arris and Gale Lecture before the Royal College of Surgeons of England and which dealt with etiology, anatomy and surgical repair of cleft palate, has been previously published.

Dorrance and Bransfield[32] elaborate upon the anatomy of the cleft palate and stress the necessity of a push-back operation in almost every cleft palate case. Conway[29] describes the anatomy of the pterygopalatine canal and its neurovascular contents. He removes a portion of the posterior wall of this canal to facilitate the backward displacement of the muco-

periosteal flap and soft palate in the process of doing the set-back operation.

Baxter and Cardoso[8] apply skin grafts to the nasal aspect of the mucoperiosteal flaps in cleft palate repairs to prevent subsequent contracture of the palate. They believe that the resulting speech following this type of repair is definitely better than that following the ordinarily advocated procedures. Albray[4] describes an obturator of value in feeding cleft palate cases. McIvor[70] describes a new atraumatic mouth gag.

Stephenson and Robinson[78] have prepared a report of the clinic presented by Padgett at the Kansas City meeting of the American Society of Plastic and Reconstructive Surgery. About 35 cases of harelip and cleft palate defects that had been repaired were presented.

MANDIBLE.

Byars and McDowell[22] enumerate the appliances available to control mandibular fragments after traumatic or surgical resection of a portion of the lower jaw. Loss of a section of mandible creates an immediate and serious problem which in a planned jaw resection is met by a previously prepared scheme. Interdental wiring, of course, offers the simplest solution. The partial or completely edentulous mouth, and children present a more complex situation. Children's teeth do not permit splinting or interdental wiring; it is, however, comparatively simple and highly satisfactory to drill small holes in the ends of both fragments and insert a stainless steel bar to bridge the defect. It is extremely desirable to do a subperiosteal resection if the pathological lesion permits. The mandible will regenerate surprisingly well following such a resection, and subsequent bone grafting is not needed.

In the edentulous and in cancer patients where an extensive lesion and large segment of the mandible must be resected, the position of the bony fragments is well maintained by a similarly inserted stainless steel bar (see Fig. 12). Bone grafting may later be done. Those factors which limit the

movement of the mandible are enumerated. Condyloid resections are discussed.

Brown, Peterson, Cannon and Moore[16] report an unusual case of marked facial asymmetry and malocclusion secondary to a unilateral hyperplasia of the mandible. Roentgenological examination revealed an elongation of the condylar neck; deepening of the sigmoid fossa and a thickened mandibular body. The condyle and its neck were removed at operation. The teeth were brought into occlusion by elastic traction, which was maintained for four weeks. The temporal and masseter muscles soon elevated the side of the mandible. The cosmetic result was pleasing; normal function and good occlusion were restored.

Gordon[44] believes interosseous wiring is applicable in fractures of the edentulous mandible, multiple fractures, bilateral fracture through the mental foramina with downward displacement of the central fragment, gunshot wounds and fractures at the base of the condyle with displacement. Likewise, it is often the easy way to manage a mandibular fracture complicated by an edentulous posterior fragment.

Blocker[9] stresses the importance of bone grafting in the lower jaw, even though it is met with infrequently in civilian life. He prefers to use iliac block grafts of pure cancellous bone for the repair of large, as well as small, bony defects in the mandible. The value of an adequately prepared recipient area with supple skin covering free of scar tissue and infection, aseptic technique and chemotherapy are stressed. Sixty-eight patients were seen at an Army plastic center, who required bone grafting of mandibular defects greater than 2 cm. The significant data in these cases is outlined.

Soderberg and Mulvey[93] relate their experiences in handling 387 maxillofacial patients in an Army General Hospital. The main problem which these patients presented was mandibular reconstruction. Such reconstruction included bone grafting, sulcus formation, tantalum prosthesis and a final revision of soft parts to improve the overall appearance of the patient. Methods of fragment stabilization are depicted and operative

procedures for bone grafting are related. Postoperative splint fixation and definitive soft tissue repair are described. Cancellous bone was used and those principles of bone healing seen in primary fracture were observed.

Barclay, Gordon and Campbell[7] analyze the care and treatment of fractures of the lower and upper jaws acquired by members of the Canadian Army in World War II. The complications of these injuries are discussed and the experiences with bone grafts to mandibular defects is related. Engel and Brodie[35] analyze 19 cases of arrested growth of the mandibular condyles. They emphasize the fact that such growth abnormality is not only of local consequence but reflects itself in marked deformities of the complete mandible and in facial asymmetry. Marion and Craviotto[65] advocate the application of extraoral prostheses, ladder section of the bone and immediate grafting with cancellous bone chips as an operative technique for the correction of micrognathia.

CARCINOMA.

Erich[36] writes on carcinoma of the lip. A general discussion of the methods of treatment which have been found most effective at the Mayo Clinic is presented. For precancerous lesions, the entire exposed part of the mucous membrane of the lower lip is excised. The defect is repaired by suturing the remaining edge of mucous membrane to the skin border. Methods are outlined for repair of defects resulting from carcinoma of the lower lip which do not involve more than a third of that structure, and immediate repair is carried out. Larger defects are repaired by advancing the tissues of the cheek to the midline after lateral incisions have been carried through the corners of the mouth. More extensive carcinomas involving a greater portion of the lip, the underlying periosteum and perhaps the bone are removed by electric coagulation. Later, repair is done by chest flaps. In grade I carcinoma it is felt that the prophylactic removal of the cervical nodes is not indicated. Grades II or III squamous cell epitheliomas are so prone to produce cervical metastasis that prophylactic dissection, removing the submental and submaxillary nodes and the

upper nodes of the jugular chain, is routinely carried out. In grade IV carcinoma, it is not felt that dissection is justified, and external irradiation is applied to the neck. If operation is contraindicated in groups II or III carcinoma, irradiation is used. Occasionally in old and debilitated people, radon seeds are implanted directly into solitary metastatic nodes. It is felt at the clinic that carcinoma of the lip is curable in practically all cases, if the primary lesion is treated early and neck dissection carried out judiciously.

W. B. Macomber and Paletta[61] emphasize the importance of considering the diagnosis of carminoma when skin lesions in the military age group are examined. Their objectives in the treatment of a tumor is wide excision, direct closure if possible, skin grafting if necessary, reconstruction after a period of six months to a year following the removal of large malignant lesions, and the replacement of temporarily applied skin grafts by multiple excisions. The surgical removal and immediate repair is discussed in forehead, eyebrow, eyelid, cheek, nose, lip, ear and mouth lesions.

Halpert and Patzer[47] report the removal of a benign neoplasm of the maxilla of an infant six months old. Microscopic examination of the tissue showed it to be composed of retinal anlage. It is believed to be the first such tumor recorded. Mohs[72] describes the chemosurgical treatment, a microscopically controlled method of excision, as applied to carcinoma of the ear.

FACIAL REPAIRS.

Cannon, Brown and Peacher[24] stress the importance of a good viable resurfacing of the scalp prior to the repair of a cranial defect. A well healed good surface covering is a prerequisite for successful deep surgery. At the time of debridement of cranial cerebral wounds, closure of the scalp may be accomplished by approximating the skin edges, skin grafting or advancing of direct single or double pedicle flaps. It is important to later plastic repair that as few as possible additional scars be made in the adjacent scalp. The simple closure of the wound or the use of a skin graft rather than the shift-

ing of flaps makes possible a better later repair. Several methods deserve consideration in preparing a good surface for the final cranioplasty or further cortical exploration. Small, thin craniotomy scars may be excised and closed. Extensive defects of the frontal region may be completely exposed by coronal excisions. The usual craniotomy incision may be followed in the temporal region. Relaxing excision can be used in small defects, but special care must be taken not to expose the tantalum plate. Direct, local, single or double pedicle flaps may be employed in the temporal, parietal and occipital regions. Distant delayed flaps are indicated in the frontal region where a local hair-bearing flap would be quite unsuitable.

Peacher, Cannon and Brown[79] relate their experiences using tantalum, bone and cartilage in the repair of skull defects. Tantalum has been found very satisfactory, particularly in the repair of large defects of the vertex. It is possible to insert a tantalum plate uneventfully into a soiled field. Special attention should be focused on adequate scalp nutrition. Orifices in the tantalum offer no special advantage. The scar tissue extending through such openings may produce noticeable depressions in the scalp and forehead. Tantalum may be deleterious if subsequent deep radiation therapy or diathermy is used. If complications develop, its opacity interferes with roentgenological diagnostic procedures. If only a very limited bony margin can be exposed, tantalum should not be used. In children, the growth factor must be considered. Bone is particularly useful in the repair of defects involving the frontal regions, as it may be shaped so as to preserve the delicate contour of the glabella, supraorbital, nasal and zygomatic processes of the frontal bone. Where only limited exposure of a small or moderate sized defect is possible, bone is the more desirable material for repair. It should be used in the repair of cranial defects of children, and where deep X-ray therapy. diathermy or pneumoencephalography is being subsequently anticipated.

Cartilage is used over nonpulsating defects of the orbital region and frontal sinus. It may be used to fill the defects

resulting from depressed fractures of the outer table of bone or to fill in residual depressions when bone grafts have been used. Bony prominences of the face may likewise be restored by cartilage transplants.

Kazanjian[53] remarks on the merits of the surgical and prosthetic methods of correction of maxillofacial deformities, placing particular emphasis on those defects resulting from the operative treatment of malignant lesions. He describes a case in which the nose, lip and maxilla were satisfactorily restored by a combination of surgical and prosthetic procedures.

Lloyd and Braund[58] discuss in some detail the problems of maxillofacial prostheses in patients with carcinoma. The defects resulting from treatment of cancer of the head and neck may not only be disfiguring but they may also involve the nutritional state of the patient, his emotional outlook and his economic status. Many such defects, of course, can be corrected by plastic surgery procedures, but these are often not advisable immediately following the removal of carcinoma. A period of time may be required to determine the patient's freedom from the disease and the advisability of a prolonged repair. During this period, in order for the patient to maintain his nutritional state and to make it possible for him to face the public with ease, maxillofacial prostheses have been designed which hide the defect amazingly well. Temporary appliances may be designed to maintain facial contour and the continuity of the oral pharynx. Defects resulting from destruction of the maxilla may be constructed in the form of obturators and thus separate the oral from the nasal cavity. Similarly, obturators may be constructed to replace the destroyed soft palate. The technique for obtaining the impression in such cases is outlined. Likewise, prosthetic devices to replace mandibular defects are described. Since one-third of all cancers occur in the skin, and particularly the skin of the face and neck, there are numerous facial defects created yearly. The construction of prostheses for the nose and ear are given in some detail. Methods to construct protheses for the type of defect resulting from the destruction of the orbit and its contents are briefly mentioned. Some 55 cases during the past year have been

treated. The reports of six are given in detail and with accompanying photos.

Blocker[10] emphasizes the necessity of a well thought out plan of facial repair, with due emphasis on the patient's personality and other features. He stresses the importance of simple procedures and advises their use when at all feasible.

Straatsma[98] enumerates the basic principles of technique which are useful in obtaining fine scars. He emphasizes a right angle incision, adherence to tension lines, adequate relaxation of skin edges, fine external sutures, early removal of skin stitches and support of wound edges.

Hadjistamoff[46] describes the reconstruction of full thickness loss of the cheek by using the skin of the jaw and neck region. Mills and Patterson[71] demonstrate pictorially the uses of the Z-plastic, multiple excisions and sliding flap methods in the correction of acquired and congenital anomalies of the face and neck. Newman[74] makes use of tantalum in the correction of facial defects, using as illustrations defects of the orbital rim and zygomatic arch. Tantalum plates can be cast so as to restore facial symmetry. The metal is anchored at three points. Adams[3] re-emphasizes the importance of using the remaining skin of the face in the correction of facial defects. W. B. Macomber and Berkeley[62] review the literature and supply illustrative cases for the use of tubed pedicles in the restoration of facial defects.

MISCELLANEOUS.

Pierce[83] corrects an habitual frown by making an incision through the medial end of each eyebrow and exposing the corrugator supercilii and excising a good portion of the body of the muscle.

MacFee[59] reviews the origin and development of hemangiomas. Their classification is discussed. Various forms of treatment available for these lesions are enumerated. The relative merits of various forms of treatment, however, are not dealt with, but the application of surgical procedures to large he-

mangiomas is discussed in those cases in which surgery is considered the appropriate form of treatment. The danger of severe hemorrhage is emphasized, and the ligation of the external carotid is used to eliminate this hazard. Temporary control may be secured by a traction thread around the vessel. The surgical objective should be complete removal of the entire lesion, including the involved skin. Prompt healing is promoted by the use of free skin grafts. It is advised that the repair of residual defects be planned, and the procedure carefully timed and carried out under suitable conditions.

Conway and Docktor[28] feel that current methods of treating capillary hemangiomas leave much to be desired. The replacement of such lesions by free skin grafts is not entirely satisfactory. They propose intradermal injection of permanent pigment to neutralize the color of port-wine stains. The history of tattooing and its modern applications in plastic surgery are reviewed. The technique of injecting capillary hemangiomas with electromagnetic needles is outlined. Microscopic study of sections obtained from capillary hemangiomas neutralized by tattooing show a deposition of the pigments in the upper dermal layers. Seven cases are reported in which the results are quite satisfactory.

LaFerte[57] emphasizes the importance of the platysma in the etiology of congenital torticollis. His method for the correction of this deformity is described. It is necessary to consider the necessary readjustment of the eyes following the corrective procedure and return of the head to normal position.

Hayes Martin[66] discusses instruments that are useful in operations on the head and neck. Weiss[103] describes a pen for skin marking. Chase[26] reports on a new eschar treatment for the local treatment of burns. May[67] has devised a clamp to both test and improve the circulation of a pedicle flap. Goodall and Flanders[43] review a case in which primary suture of Stenson's duct was successful. The anatomy and operative procedure is outlined. A. M. Brown[12] discusses the place of a prothesis department in a teaching hospital.

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CENTRAL ILLINOIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY.

The next meeting of this Society will be held at the Abraham Lincoln Hotel in Springfield, Ill., Nov. 12, 13 and 14. The officers of the Central Illinois Society of Ophthalmology and Otolaryngology are: President, Dr. Clarence E. McClelland, Decatur, Ill.; President-elect, Dr. Clifton T. Turner, Peoria, Ill.; Vice-President, Dr. Harold Watkins, Bloomington, Ill.; Secretary-Treasurer, Dr. Philip R. McGrath, Peoria, Ill.

NATHANIEL HIGHMORE, SEVENTEENTH CENTURY PIONEER IN ANATOMY AND EMBRYOLOGY.

1613-1685.

WALTER A. WELLS, M.D.,
Washington, D. C.

Because of its incorporation in certain well known medical terms, Highmore is a familiar name to all doctors; but few of them have any knowledge of the person thus honored.

Even rhinologists who can hardly pass a day without hearing or speaking this name would probably not care to have their I. Q. rated by their ability to answer such questions as, "Who was Nathaniel Highmore," "When and where did he live and how did his name come to be associated with the maxillary antrum?"

There are two eponyms which bear his name:

1. Highmore's antrum, or, as it is more often called, the antrum of Highmore, is the largest and most frequently affected of all the nasal accessory sinuses. It is a pyramidal shaped cavity of about a half-ounce capacity, situated within the body of the upper maxilla on each side; it is separated from the nasal cavity by its inner wall (partly membranous) at the top of which there is a communicating opening (ostium). The high situation of the latter makes it unsuitable for drainage by gravity in case of abscess.

The upper wall of the antrum separates it from the cavity of the orbit; the lower is in relation to the roots of the molar teeth and, though relatively thick, it is sometimes pierced by them, thus offering a route for infection.

Highmore's attention was called to the maxillary antrum by his having a patient suffering from an abscess in this location. It was on the left side and draining into the mouth through an opening made by the removal of a tooth.

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Because of this experience, he made a particular study of the anatomy of this region, and he described it with considerable detail, and with illustrations in his general treatise on anatomy, entitled "Corporis humani disquisitio anatomica in quo sanguinis circulationem persequtus est." The Hague, 1651 (p. 126).

2. *Highmore's body* is the name given to a mass of fibrous tissue located on the posterior surface of the testis. It is continuous with the tunica albuginea, and it projects forward in the testis along its posterior border; mediastinum testis. It is also described in the above mentioned treatise.

Nathaniel Highmore was born in February, 1613, which was the tenth year of the reign of James I, whose stubborn policy laid the foundation of the deadly war that was to break out in the reign of his son, Charles I.

Cromwell, who was to be the great commanding figure in that war, was yet a school boy, little dreaming of what the future had in store for him.

Harvey, now just 35 years of age, was a physician at St. Bartholomew's Hospital, mulling over the problem of blood circulation, which only three years later he was to touch upon in his Lumleian lectures.

Nathaniel was the son of Nathaniel, rector at Purse-Caundle parish in Dorsetshire.

It was traditional for the Highmore family to have always some member of that name occupying a Church of England pulpit — a tradition which was to continue for this particular parish for the following century.

Nathaniel, however, had other ideas for himself. He had an ambition to enter the profession of medicine.

In 1631, at the age of 17, he matriculated at Queens College, and the year following he became a scholar at Trinity College, Oxford. He spent 10 years as a student at Oxford, the early years being given to science, philosophy and the classics, and later taking up medicine. He received his degree of Bachelor of Medicine in 1641, and became Doctor of Medicine in 1642.

While he was still in residence, there came to Oxford a personage who greatly impressed and influenced him.

When shortly after the battle of Edgemere the King moved the Court to Oxford, he had in his retinue as his personal physician the great William Harvey, then, as always, more interested in science than in the political bickerings which marked the age.

On his arrival at Oxford he was already famous as the discoverer of circulation and was beginning to occupy his mind with a new study; namely, the problem of regeneration.

Aubrey, in his quaint chronicles of the era, writes: "He came frequently to our college of Trinity to visit George Bathurst, who had a hen to hatch eggs in his chamber to see the progress and the way of generation."

Highmore, being a Trinity man, no doubt had good opportunity to observe these experiments and to become well acquainted with the great doctor; in fact, the acquaintance so begun developed into a lasting friendship.

The experiments he witnessed in embryology led him to take up this work himself, and by coincidence he and Harvey published treatises on the subject in the same year (1651).

On leaving Oxford, Highmore settled for practice in the small country town of Sherbourne, in Dorsetshire, an old picturesque village, the seat of an architecturally famous abbey, and a historically famous castle.

He became very successful in practice and his renown extended far into the surrounding country.

Connected as his family was with the church, he had many clergymen among his patients, and it is related to his credit that he never accepted a fee from any of the profession.

Highmore is not esteemed one of the truly great anatomists of the past, but he is, we believe, rightly entitled to the designation we have given him of being a seventeenth century pioneer in anatomy.

The early pioneers in this science were the great Italian anatomists of the preceding century.

But Italy had fallen behind, and the lead had been taken over by enthusiastic investigators in other lands to the north, and among these Highmore was one of the earliest.

Germany, devastated and impoverished by the seven years' war, was producing nothing, but England and Holland had become rich and prosperous by reason of expanding commerce, and it was in these two countries that the medical sciences now flourished.

Leyden was the great seat of learning and it had become the favored training center for many English students of medicine. Denmark and Holland, by their proximity, shared in the advantages offered, and we find then these countries leading in the great development of anatomy and physiology for which the seventeenth century is distinguished.

With the exception, however, of Harvey, whose immortal "De motu cordis" was published in 1628, most of the classic treatises did not appear until after the middle of the century, and nearly all at a later date than that of Highmore, which was published in 1651.

The Danish anatomist, Thomas Bartholin, published "De lactibus" in 1652, the Swedish anatomist, Olof Rudbeck, his "Nova Excitatio Anatomica" in 1653, and then in England we had the classic "De Hepate" of Francis Glisson in 1654, and the "Adenographia" of Thomas Wharton in 1656; then, in 1662, appeared the "Observationes Anatomicae" of the learned Dane, Niels Stensen, and the following year the "Disputationes Medicae" of the great Leyden professor, Franciscus Sylvius. In 1664, Thomas Willis published his famous work on the anatomy of the brain. In 1669, we had Richard Lower's treatise on the anatomy of the heart, and, in 1691, Clopton Havers on the anatomy of the bones. Regmer De Graaf's famous treatise on the anatomy of women appeared in 1672, but the great Dutch anatomist of the era, Frederik Ruysch, did not publish his "Thesauri Anatomici" until the beginning of the next century (1701).

Highmore dedicated his treatise to his friend Harvey ("Excellentissimo et Ornatissimo Viro Doctori Harveo") and a good part of its was devoted to the discussion of the blood circulation, which he warmly championed.

This was by no means a superfluous gesture, for, although Harvey's conclusions had been published some 23 years before, they were still far from being generally accepted.

The subject was still under discussion and was debated pro and con in medical circles at home and abroad and at times with much asperity.

In England, besides Highmore, the new theory received the support of Frances Glisson, Stephen Hales and Richard Lower. It was, however, bitterly assailed by Dr. James Primrose.

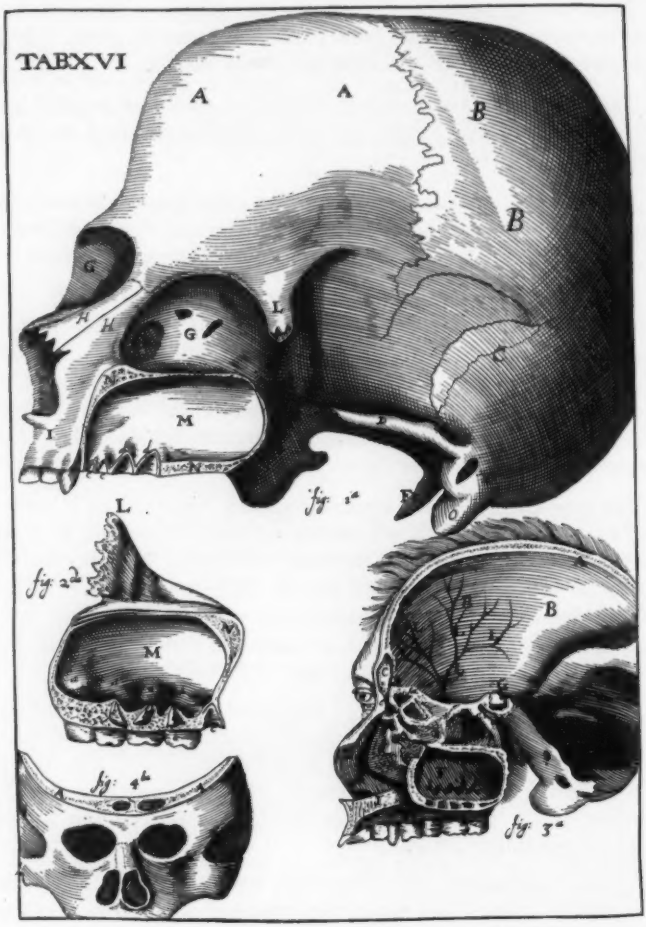
Abroad it was championed by Stensen and Sylvius in Holland, Bartholin in Denmark, and Vieussens in France; but it met uncompromising opposition at the hands of the faculty of the University of Paris. This was, at that time, the most reactionary medical center in Europe, where Galenism was still in a measure entrenched, and where scholasticism and barren disputation were the order of the day.

The new theory of the circulation was regarded as a heresy and members of the faculty were actually forbidden to have anything to do with anyone who advocated it. Harveyites were, so to speak, excommunicated. The influential Dr. Guy Patin denounced the circulation theory as "paradoxical, useless, false, absurd and harmful," and Dr. Riolan, dean of the faculty, denied it to his dying day.

Rene Descartes, who was physiologist as well as a philosopher, and whose opinion was highly regarded in the medical world, did much to retard its acceptance. He clung to the ancient theory that the movement of the blood was due to generation of heat within the heart, and not to the motor force of muscular action.

Another great medical discovery was in process of evolution during these days when the question of the blood circulation was being discussed.

It was one which was supplementary to it, and which had much to do with its ultimate acceptance. We refer to the discovery of the lacteals and lymphatics.



As early as 1622 an Italian physican, Gasparo Aselli, had observed small vessels in the mesentery filled with a milk-like fluid, but their significance was not understood, as he regarded them as veins and supposed that they terminated in the liver.

In the year 1651, the same year in which Highmore published his treatise defending Harvey's theory of the circulation, a French physician, Jean Pecquet, made known his discovery of the *receptaculum chyli.* He showed that it was into this "cistern" that the lacteals emptied their contents, and that the stream continued through the thoracic duct, to empty into the junction of two large veins, the jugular and the subclavian.

Two years later the Swedish anatomist, Rudbeck, discovered another set of vessels, the lymphatics, which likewise poured their contents into the thoracic duct.

He had no sooner published this discovery, when rival claims were announced from other quarters. Dr. Glisson stated that a pupil of his named Jolive had made the same observation, and Thomas Bartholin, of Denmark, also claimed the discovery as his own.

A bitter contest on the subject of priority was waged between Rudbeck and Bartholinus.

Harvey was at first reluctant to accept the lacteals as specific chyle-carrying vessels. He considered them rather in the light of overworked veins. It was the special contribution of Highmore in this connection that he was the first to definitely point out the distinction between lacteal vessels and mesenteric veins.

Harvey published, in the year 1651, a treatise on embryology (De Generatio Animalium) and there are some of the opinion that his work on this subject deserves to be ranked as of equal importance as that on circulation. Perhaps it would have been had not much of his manuscript been destroyed when the Roundheads raided his quarters in Whitehall.

Much credit is rightly given Harvey for having been the first to insist upon the fundamental principle, *omnes vivum*

ex ove, but we must look upon this as a brilliant conception rather than as a statement based upon scientific observation and experiment as in the case of the circulation theory.

He knew nothing at the time of the ovary-producing functions of the ovaries, as they came to be known later by the studies of DeGraaf, Stensen and Von Beyer.

Highmore published also a treatise on embryology in the same year that Harvey did. It was entitled "A history of generation, examining the opinions of Sir Kenelm Digby."

There is no evidence that either author was aware of the intentions of the other to write on this subject. The coincidence is the more remarkable for the reason that until then the subject had received almost no attention since the most ancient times.

It was still generally believed that fertilization occurred as the result of a mixture of male and female seed, and that some living organisms could develop as taught by Aristotle as a result of spontaneous generation. There was a division of opinion as to whether the embryo existed in a completely preformed state from the beginning or whether it developed by a gradual step by step new formation and addition of parts (epigenesis).

Both Harvey and Highmore employed the dissection of the hen's egg to study the successive stages of the development of the embryo, and it is evident neither subscribed to the ancient theory of the preformed organism, but adopted as a working basis the modern idea of epigenesis.

Harvey is supposed not to have believed in spontaneous generation, but Garrison says that he apparently subscribed to the idea that some worms could develop spontaneously in putrefactive matter.

Highmore was a frank defender of the theory of spontaneous generation, a theory which, although it had some of the props knocked from under it by the experiments of Francesco Redi in 1668, continued strong for another 200 years, when

it was completely demolished by the conclusive demonstrations of Pasteur.

Irrespective of our estimate of Highmore's work in the field of embryology, there is one distinction which he deserves in this connection which the historians seem to have completely overlooked.

He was, we believe, the first to employ the microscope as an aid in this study. The microscope was discovered in the beginning of the seventeenth century, but it was not until about the middle of the century that it began to be used for the investigation of subjects of interest to medicine.

Noted as the first to employ it for this purpose were Athanasius Kircher (1602-1680), Marcella Malpighi (1628-1694), Anton van Leeuwenhoek (1632-1723), Robert Hooke (1635-1703) and Jan Swammerdain (1637-1680).

Kircher, in 1658, published his observations of what he thought to be living organism in the blood; Swammerdain, in the same year, published his report of the discovery of red blood corpuscles, Hooke, in 1665, his "Micrognophia" dealing chiefly with the histology of vegetable structures, and van Leeuwenhoek made public his extensive microscopical observations in reports to the Royal Society beginning in 1672.

Malpighi is often referred to as the first to use the microscope in the study of embryology, but in 1651, when Highmore's treatise was published, Malpighi was just beginning his medical studies; in 1662, he published his famous treatise, "De Pulmonibus," on microscopical examination of the lung tissue, but his first embryological treatise, "De Formatione Pulli in Ovo," did not appear until 1673.

Twenty-two years before this, Highmore wrote: "With the white circle in the middle which was much dilated there appeared a red sparkling line encompassing the white spot now red too and moving, which motion plainly showed it was the heart, and afterwards I saw by *the help of the glass of the microscope*, exactly showing me the heart perfectly formed with both his ears and this red line joined to it, running quite

around the inside of the whole circle. By the help of the glass I saw the motion of the heart and ears for a long time, one anticipating the other and continuing after the other decayed."

Bound and published with the treatise on generation was another on another subject, namely, "A discourse on the cure of wounds by sympathy without any real application of medicine to the part affected, but especially by that powder known chiefly by the name of Sir Gilbert Talbot's powder."

Both of these tracts were written for the purpose of "examining the several opinions of diverse authors, but especially that of Sir Kenelm Digby in his discourse of bodies."

In one, that on the subject of generation, he disagrees with Sir Kenelm; in the other he supports his views as to the virtues of the sympathetic powder and goes to great length to find a justification for them on scientific grounds.

Sir Kenelm Digby was a very picturesque individual who played a conspicuous rôle in the history of that era. According to Aubrey, "he was a goodly handsome person, gigantic and great voiced, and had a so graceful elocution and noble address that had he dropped out of the clouds in any part of the world he would have made himself respected."

He was a soldier of fortune, diplomat, man of letters, philosopher and scientist. He was the great Sir Oracle of his day in many subjects, including medicine.

It may seem strange that a man like Highmore, a keen observer and investigator, with long years of training in traditional medicine, would follow after such shadowy will-o'-the-wisps as the sympathetic powder and the weapon salve advocated by Sir Kenelm.

The weapon salve was a salve to bring about the healing of a wound, not by being applied to the wound, but to the weapon that caused it.

The sympathetic powder, it was alleged, cured by being applied to a cloth stained with the bloody secretions of the diseased part affected.

According to Highmore, the mysterious effect was to be explained by a sort of "effusion and explanation of invisible atoms."

It seems that atoms of different sizes and shapes are constantly being pressed out of place to fly out to more suitable locations where they tend to exert a healing influence.

The cloth stained with the bloody matter having been covered with powder must be protected from air, moisture and changes in temperature; the wound in the meantime is merely to be kept covered with a dry, clean bandage.

The powder is said to have been nothing else than green vitriol dissolved in water, and recrystallized by exposure to the sun.

Highmore's faith in such incredible practices, strange as it seems, was in reality typical of the era in which he lived.

It was an era of contrast and contradiction, an era in which, though many striking advances had been made in exact science, there still prevailed an intense devotion to medieval mysticism. It was an era of reason, intelligence and learning, but it was at the same time the era of widespread belief in alchemy and witchcraft.

It was the era that produced Spinoza, Descartes and Locke, and it was the era in which men of learning spent their lives in vain search for solution of such problems as squaring the circle, perpetual motion and the discovery of the philosopher's stone. In medicine, it was the era in which the art of healing was being advanced by a rational application of observation and experiment, and in which at the same time it was being practiced by reliance on silly superstition.

It was the era that produced Harvey, Willis, Sydenham and Glisson, but it was the era of a profound belief in the virtues of the sympathetic powder, the weapon salve and the royal touch.

Sometimes these opposite and presumably incompatible characteristics occurred in one and the same person.

The learned Dr. Thomas Browne was a firm believer in witchcraft.

Sir Richard Wiseman, the foremost surgeon of the age, was an upholder of the popular faith in the potency of royal touch for the cure of scrofula, and Descartes, the founder of modern philosophy, taught that the reasoning soul had its seat in the little pituitary body at the base of the brain.

We need, therefore, not be too surprised that Highmore argued in favor of the curative value of the sympathetic powder.

Nine years later, Highmore published another treatise, entitled "De Passione Hysterica et de Affectione Hypochondriaca. Oxford 1660."

These two diseases still bear names based upon an ancient and fanciful pathology.

In Highmore's day but little progress had been made since those ancient times.

Medical men still discussed them in terms of hypothetical body humors and spirits — some a little more advanced, interposing the idea of vapors arising therefrom, an idea which long persisted in medical and lay thought.

Highmore not only did nothing to improve the situation, he actually added to the confusion. In his treatise he brought forth an absurd theory that hysteria was due to some sort of thickening or coagulation of blood in the lungs.

His theory, however, aroused much interest and provoked much comment, favorable and unfavorable, in high medical circles. It was strongly opposed by the eminent Dr. Thomas Willis, who had a great following in the fashionable world, and had no doubt many patients who belonged in this category of illnesses.

He was the leading champion in England of the school of practice known as the iatro-chemical, and he had consequently special ideas of the origin of disease in accordance with the doctrines of this school.

He wrote a treatise in reply to that of Highmore and a lively controversy on the subject ensued, which led to nowhere. Hysteria, according to Willis, was produced by a union of the spirits with blood which had been imperfectly prepared by the spleen. This induced a fermentation which was the direct cause of the disorder.

Sydenham also took part in the discussion. He advanced the idea that hypochondria in the male corresponded to hysteria in the female, and both were indications of a degenerate state of the constitution. And so the matter remained for a hundred years or more, when a radically new concept was substituted for the old by Charcot's theory of the psychogenic origin of hysteria.

The only other publications of Highmore of interest to medicine were some papers which were published in the *Philosophical Transactions* relating to chalybeate waters. He described, at length, the healing properties of the mineral spas located at Scarborough, East Charnok and other places.

Sir Robert Boyle, the famous chemist, and a founder of the Royal Society, has called attention to the fact that Highmore was a man of wide and varied interests. In a letter to the Secretary of the Society, he mentions some of these, and especially his discovery (and this might be of interest even to our modern gardener) that the most useful of all fertilizers was the earth dug from beneath old rotted wood.

Highmore died in 1685, and as it was reported that he was buried in the old church near Sherbourne, where his father had so long served as rector, Dr. Courcy Predaux set himself the task of verifying this fact, and of discovering the tomb, if possible. He reported the result of his visit to the church in a paper read at the meeting of the historical section of the Royal Society. After a long search and much trouble he discovered beneath the chancel of the old church or Purse Caundle a tablet which bore a Latin inscription which was translated to read as follows: "Here has been laid to rest, in hope of the resurrection to the life eternal the remains of Nathaniel Highmore, M.D., a man of great learning, who died 21st of March, A.D., 1685, in the 71st year of his age."

We have referred to the fact physicians, rhinologists included, knew very little about the man Highmore.

For this they are not to be blamed, because, although his name is a fixture in medical literature, Highmore has been singularly slighted by medical historians.

No portrait of him, for example, is found in the great Army Medical Library, in Washington, which makes a point of collecting all the portraits of medical men of note.

The one accompanying this sketch was fortunately found in a history of the county in England in which he lived and practiced.

It is an excellent portrait, indicating we would say, a man endowed with exceptional energy of mind and body, conjoined with an agreeable disposition.

We might further easily infer him to be, as we believe he was, a man of discernment, of imagination and with a rare talent for argumentation.

IMPROVED TECHNIQUE OF THE BILATERAL THYROTOMY FOR CARCINOMA OF THE LARYNX.

JOSEPH I. KEMLER, M.D.,
Baltimore, Md.

The bilateral thyrotomy for carcinoma of the larynx which was described in THE LARYNGOSCOPE[1] has been improved by the author as follows:

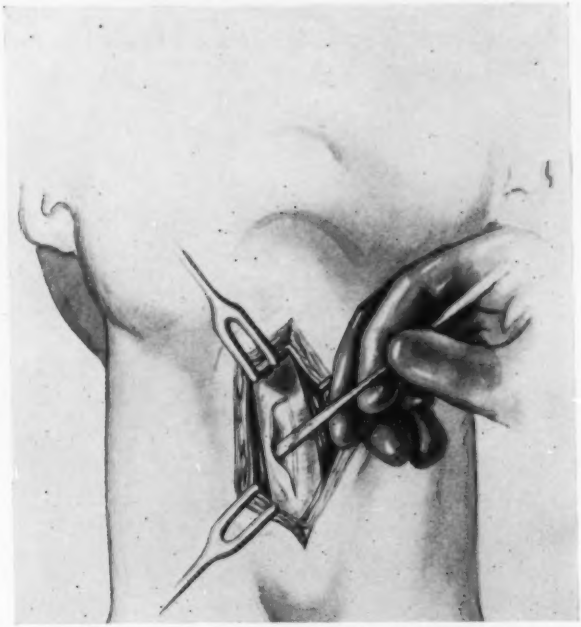


Fig. 6. External perichondrium incised in the midline and dissected on each side for 1 cm.

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The external perichondrium is incised in the midline and dissected on each side of the thyroid cartilage for 1 cm. (see Fig. 6). A superficial vertical incision in the denuded cartilage is then made on each side at this distance from the mid-

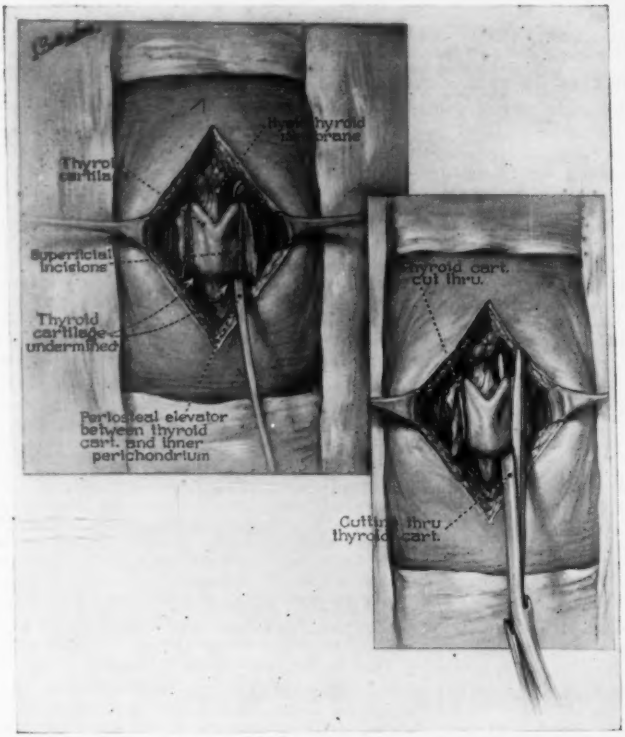
Superficial incisions
Thyroid cartilage undermined
Periosteal elevator between thyroid cart. and inner perichondrium
Thyroid cart. cut thru.

Fig. 7. Cartilage incised vertically 1. cm. on each side.

line to indicate where the cartilage is to be cut. The internal perichondrium is denuded underneath this line (see Fig. 7, upper). Then with medium heavy shears the cartilage is cut through on each side (see Fig. 7, lower). The inner perichon-

drium is then dissected on both sides as described in the original article.

This facilitates the cutting of the cartilage without injuring the inner perichondrium and it takes away 1 cm. of cartilage on each side of the crista along with the excised mass.

REFERENCE.

KEMLER, JOSEPH I.: THE LARYNGOSCOPE, 57:11:704-718, Nov., 1947.

BOOK REVIEW.

Hearing Aids and Audiometers. Report of the Committee on Electro-Acoustics, Medical Research Council, Special Report Series No. 261. Seventy-one pages. London: His Majesty's Stationery Office, 1947. Price 1s. 3d. net.

This report contains the experimental findings resulting from research during the war years carried out by the Committee on Electro-Acoustics of the Medical Research Council. The committee set out to determine the characteristics of a hearing aid which would be of service to the majority of deaf people and to satisfy itself that a hearing aid with these characteristics could be readily manufactured and supplied to the public at a reasonable cost.

Articulation tests were carried out on 228 patients who had been seen at either the Manchester University Clinic or the Otological Research Unit at the National Hospital, London. Various frequency responses in the reproducing systems were used. The general characteristic arrived at shows a low frequency cutoff at 750 c.p.s. with a flat curve to 4,000 c.p.s. with an option available through the use of a tone control of a uniformly rising characteristic starting at 750 c.p.s. This finding shows reasonable agreement with similar results obtained at Psycho-Acoustic Laboratory, Harvard University. As a matter of fact, the entire approach to the problem agreed generally with the principles and techniques in the parallel project in the United States carried on at Harvard University and Central Institute for the Deaf.

The research on audiometers showed that large discrepancies existed among results afforded by audiometers in general use. Recommendations are made for calibration of air-conduction and bone-conduction receivers (the latter is considered a troublesome problem). Speech audiometers are also mentioned.

The sizable appendix contains information about the following: characteristics of a number of British and American hearing aids; the optimum frequency response characteristic of a hearing aid; artificial ears for objective calibration of telephone receivers; method used to assess the performance characteristics of a hearing aid; the committee's design for a hearing aid; clinical testing of hearing aids; specification for pure tone audiometers; and characteristics of commercial audiometers.

The report would have been more helpful for detailed comparison with results obtained in this country if it contained more specific information concerning the articulation tests which were used.

Our British colleagues are to be congratulated for the excellent contribution which they have made to a subject which is commanding the increasing attention of otologists. Their perseverance in the face of discouraging obstacles presented by war "on the spot" deserves our highest commendation.

The report is signed by W. G. Radley, W. L. Bragg, R. S. Dadson, C. S. Hallpike, D. McMillan, L. C. Pocock, T. S. Littler. S. R. S.

HEARING AIDS ACCEPTED BY THE COUNCIL ON PHYSICAL MEDICINE OF THE AMERICAN MEDICAL ASSOCIATION.

Aurex (Semi-Portable); Aurex Model C-B, Model C-A, Model F and Model H.

Manufacturer: Aurex Corp., 1117 N. Franklin St., Chicago, Ill.

Beltone Mono-Pac; Beltone Harmony Mono-Pac.

Manufacturer: Beltone Hearing Aid Co., 1450 W. 19th St., Chicago, Ill.

Dysonic Model 1.

Manufacturer: Dynamic Hearing Aids, 43 Exchange Pl., New York 5, N. Y.

Electroear Model C.

Manufacturer: American Earphone Co., Inc., 10 East 43rd St., New York 17, N. Y.

Maico Type K; Maico Atomeer.

Manufacturer: Maico Co., Inc., North Third St., Minneapolis, Minn.

Mears Aurophone Model 98.

Manufacturer: Mears Radio Hearing Device Corp., 1 W. 34th St., New York, N. Y.

Microtone T-4 Audiomatic.

Manufacturer: The Microtone Co., 4602 Nicollet Ave., Minneapolis, Minn.

Otarion Model A-1; Otarion Model A-2; Otarion Model A-3; Otarion Models A-4 J and S; Otarion Model E-1.

Manufacturer: Otarion Hearing Aids, 448 N. Wells St., Chicago, Ill.

Paravox Models VH and VL; Paravox Model XT; Paravox Model XTS.

Manufacturer: Paraphone Hearing Aid, Inc., 2056 E. 4th St., Cleveland, Ohio.

Radioear Masterpiece; Radioear 45-CM; Radioear Model 45-M-magnetic air conduction receiver; Radioear Model 45-M-magnetic bone conduction receiver.

Manufacturer: E. A. Myers & Sons, 306 Beverly Rd., Mt. Lebanon, Pittsburgh, Pa.

Ravox (Semi-Portable).

Manufacturer: Zenith Radio Corp., 6001 W. Dickens Ave., Chicago, Ill.

Silver Micronic Hearing Aid.

Manufacturer: Micronic Corp., 101 Tremont St., Boston 8, Mass.

Solopak Hearing Aids.

Manufacturer: Allen-Howe Electronics Corp., 150 Main St., Peabody, Mass.

Sonotone Audicles No. 530, No. 531 and No. 533; Sonotone Model 600; Sonotone Model 700.

Manufacturer: Sonotone Corp., Elmsford, N. Y.

Telex Model 22; Telex Model 612; Telex Model 900; Telex Model 1020; Telex Model 1550.

Manufacturer: Telex, Inc., Minneapolis 1, Minn.

Trimm Vacuum Tube No. 300.

Manufacturer: Trimm, Inc., 400 W. Lake St., Libertyville, Ill.

Unex Model "A."

Manufacturer: Nichols & Clark, Hathorne, Mass.

Vactuphone Model 3.

Manufacturer: Allen-Howe Electronics Corp., 150 Main St., Peabody, Mass.

Western Electric Orthotronic Model 125; Western Electric Model 63; Western Electric Model 64; Western Electric Models 65 and 66.

Manufacturer: Western Electric Co., Inc., 120 Broadway, New York 5, N. Y.

Zenith Radionic Model A-2-A; Zenith Radionic Model A-3-A; Zenith Radionic Model B-3-A; Zenith Model 75.

Manufacturer: Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

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Executive Secretary: Dr. William L. Benedict, Mayo Clinic, Rochester, Minn.
Meeting: Chicago, Ill., Palmer House, Oct. 10-15, 1948.

AMERICAN SOCIETY OF OPHTHALMOLOGIC AND OTOLARYNGOLOGIC ALLERGY

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